January 17, 1911.

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POWER

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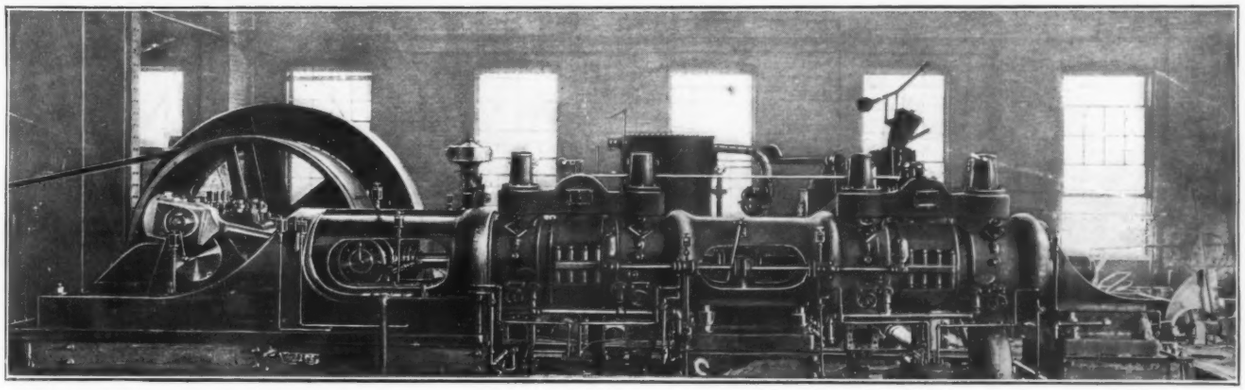
Index to Advertisers Follows Reading Matter

Muenzel Gas Engines and Gas Producer Power Plants for Electric Service



YES! You have seen this cut before. This is the engine which we installed at Aberdeen, So. Dak. Since that time, however, we have sold two duplicates of this engine. One will be installed at Fairmont, Minn., in the same Municipal Electric Light Plant in which we have had two of our engines running for several years, so they ought to know what they are doing. The other will be installed at Brainerd, Minn. These people have investigated carefully and find that our claims for the reliability and economy of **Muenzel** Gas Engines and Producer Plants are just as advertised.

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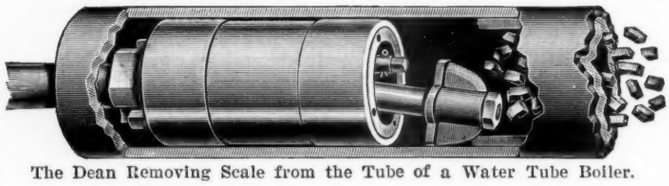
Look for Scale before it makes its presence known



The Dean Removing Scale from the Tube of a Water Tube Boiler.

Scale betrays its presence in time.

Slow steaming—

Leaky and burned out tubes—

Increase in fuel consumption—

These are the signs of scale.

You will experience them sooner or later no matter how much you physic your boilers with compounds.

They are bound to come, for scale can't be prevented.

Look for scale before you see the signs—before scale has done its work.

There's many a boiler that has from 200 to 600 pounds of scale on the tubes—and yet no signs to show the presence of scale.

At least the engineer fails to see them. It takes

The Dean Boiler Tube Cleaner

to find out the true condition of a boiler.

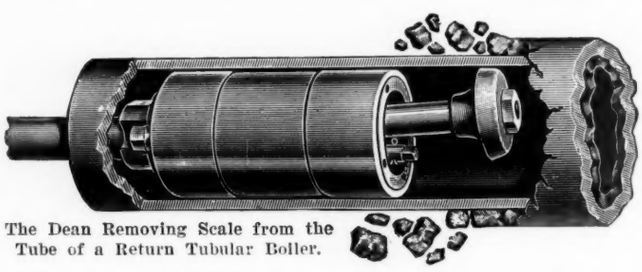
We have often sold a Dean where people had no idea whatever of purchasing it when they consented to give it a trial.

The results it produced were simply irresistible.

Results that both the engineer and owner could see.

The Dean is the one tube cleaner that cleans the tubes clean.

That's because it does its work by vibration. You need a Dean to detect the presence of scale. Just as you need a water gauge to determine the height of the water.



The Dean Removing Scale from the Tube of a Return Tubular Boiler.

The best part of it is you don't have to purchase the Dean until you have satisfied yourself that you need it, and that it will do your work better than anything else for the purpose.

Don't you want to try a Dean in one of your boilers free of charge?

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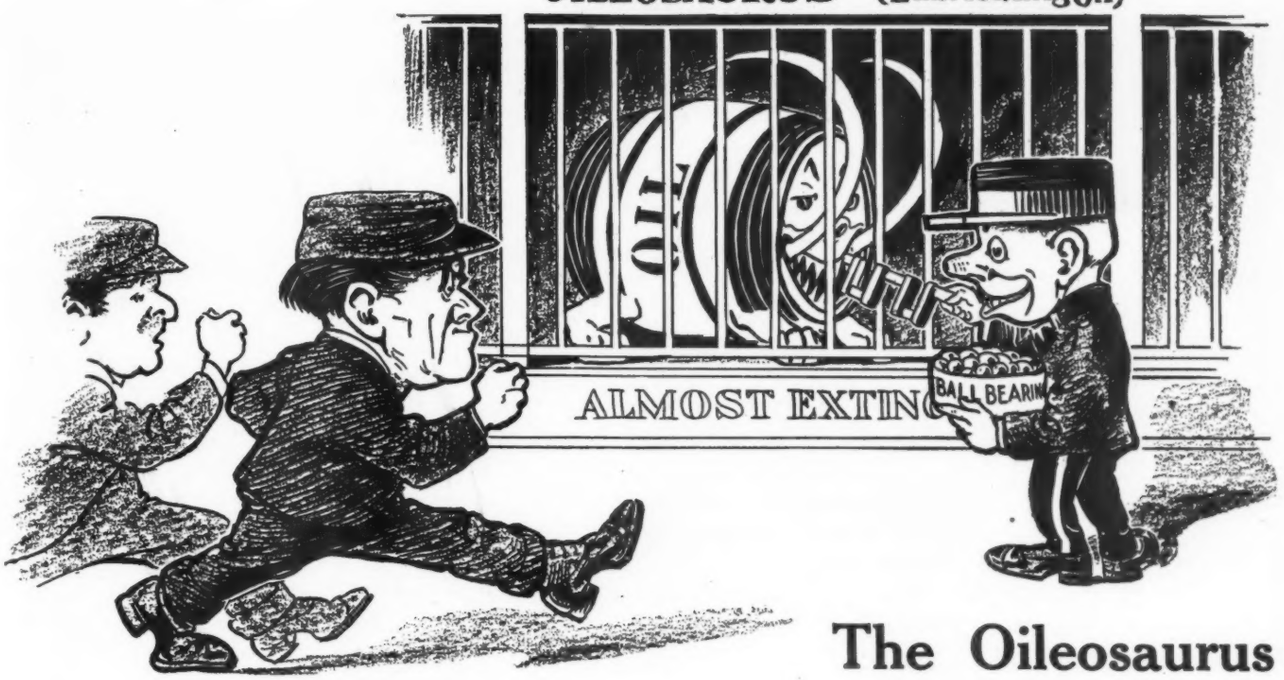

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The Simple Keeper one day gave the Oil Beast some Crank Shafts and Ball Bearings just to see what the monster would do.

Do? Why it chewed 'em up just as fast as it devoured its regular diet of Babbitt Boxes.

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Its width . . . . . Combined horse power of engines . . . . . .
FIRM. . . . . .
Per . . . . . .
City . . . . . State . . . . . .

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So Why Waste Time in Trying.

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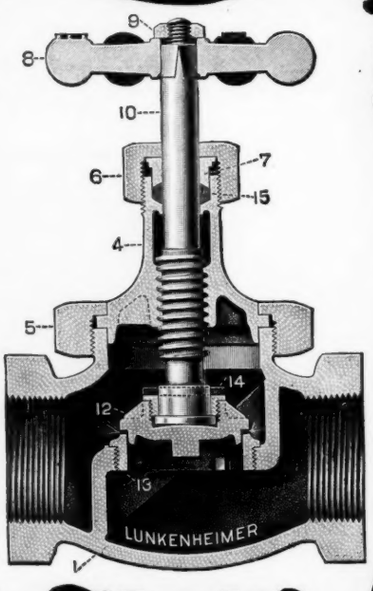
Ask any engineer who has ever used LUNKENHEIMER "RENEWO" VALVES and if you will be guided by his advice we feel satisfied that you will adopt them.



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POWER

NEW YORK, JANUARY 17, 1911

Do you recollect the first time someone took you to a circus? You were a boy then, but the memory of the event will always be bright.

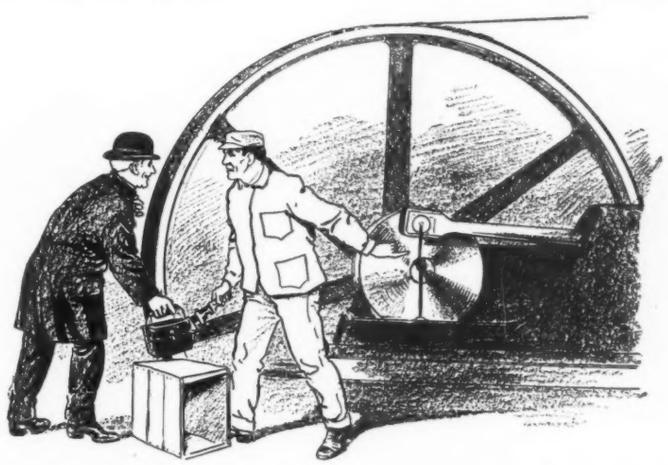
Some events in life are difficult to forget, and some are remembered with the keenest pleasure.

A truth known the wide world over is that the man who helps another gets more out of the act than the one helped. There is nothing to compare with that satisfied, full, "under the belt" feeling that creeps over a man when he has helped another to do something worth while, and the act of giving a helping hand to another has often resulted in the formation of a life-long friendship.

And the other fellow—well, he can't do much or say much, but he does a whole lot of thinking, and with him you are "IT."

There is some satisfaction in being appreciated, even if it is by the man who is running the little forty-horsepower plant.

There are thousands of engineers, many holding "high up" positions, who are not above giving a lift to the little fellow—glad to give him the boost that is just necessary to enable him to get on his feet and toddle along alone.



Some engineers may recollect the time when they were new to the game, when they didn't know whether they were playing hide and seek or blind man's buff, and sometimes felt as if both games were on at once. They didn't know whether the top or bottom adjusting bolt on the crank rod tightened or loosened the wedge back of the brasses.

And just then Bill Somebody from down at the big power plant, on his way home after a day's work, saw the puzzled, undecided, hesitating expression, and, guessing the trouble, placed his dinner box on the old wooden box that was used for a tool chest, and in a minute had shown the way to properly adjust the brasses.

Or, it might be the crosshead shoes, the valve gear, or any one of a thousand other that bother the new beginner and at intervals, the old timer.

In every case where assistance is given it is the better part of a man's nature that prompts the action. There is no expectation of obtaining anything in return and nothing is wanted. It is one of the characteristics that go to make up the average engineer—and it pays, sometimes, in dollars and cents, but most often in the knowledge that a fellow man has been helped to help himself.

Hudson Manhattan Power Station

By F. R. Low

Boiler-room practice in a plant which produces current at less than 0.42 of a cent per kilowatt-hour and makes a thousand pounds of steam with 12.5 cents worth of coal. It is enabled to do this by the use of No. 3 buckwheat. The article describes the furnace and methods by which this is successfully done, notwithstanding the varying load.

The station at Jersey City which furnishes power for the operation of the trains in the McAdoo tunnels under the Hudson river is called upon to supply a load fluctuating momentarily from 8000 to 16,000 kilowatts and swinging from 1500 kilowatts in the early morning hours to 13,000 on the morning and evening peaks. Current is supplied by two 6000- and two 3000-kilowatt generators, driven by Curtis turbines to supply steam for which eight Babcock & Wilcox boilers of 900 rated horsepower each have been installed. Some of the dimensions and proportions pertinent to this article are as follows:

Water-heating surface per boiler, sq.ft.	9,128
Grate surface per boiler, sq.ft.	190
Water-heating surface per square foot grate surface, sq.ft.	48.05
Total rated boiler horsepower	7,200
Total rated capacity of generators, kw.	18,000
Maximum sustained capacity of generators, kw	28,000
Boiler horsepower per kilowatt, rated	0.40
Boiler horsepower per kilowatt, maximum	0.26
Water-heating surface per kilowatt, rated, sq.ft.	4.06
Water-heating surface per kilowatt, maximum, sq.ft.	2.61
Grate surface per kilowatt, rated, sq.ft.	0.084
Grate surface per kilowatt, maximum, sq.ft.	0.054

While this is a generous amount of boiler and especially of grate surface for the present demands upon the station, the character of the service is such that no interruption is admissible and no chances could be taken of being found short of steam-generating capacity. Furthermore, it was believed by John Van Vleck, its designer, that a station thus of necessity liberally supplied with grate surface could be run upon No. 3 buckwheat, although none of the large power stations in this vicinity are being so run today and it is doubtful if it is being done elsewhere by a plant carrying a load of this magnitude and with this degree of variation.

Some difficulty was at first experienced in doing this, but a proposition was submitted by the McClave-Brooks Company, of Scranton, Penn., in which they agreed to burn No. 3 buckwheat, without the formation of clinker, to keep the boilers running at the required capacity, with a low per cent. of carbon in the ash, and to burn 35 pounds of this coal per hour per square foot of grate surface with not over 2.5 inches water pressure of air in the ashpit.

In accordance with this agreement the

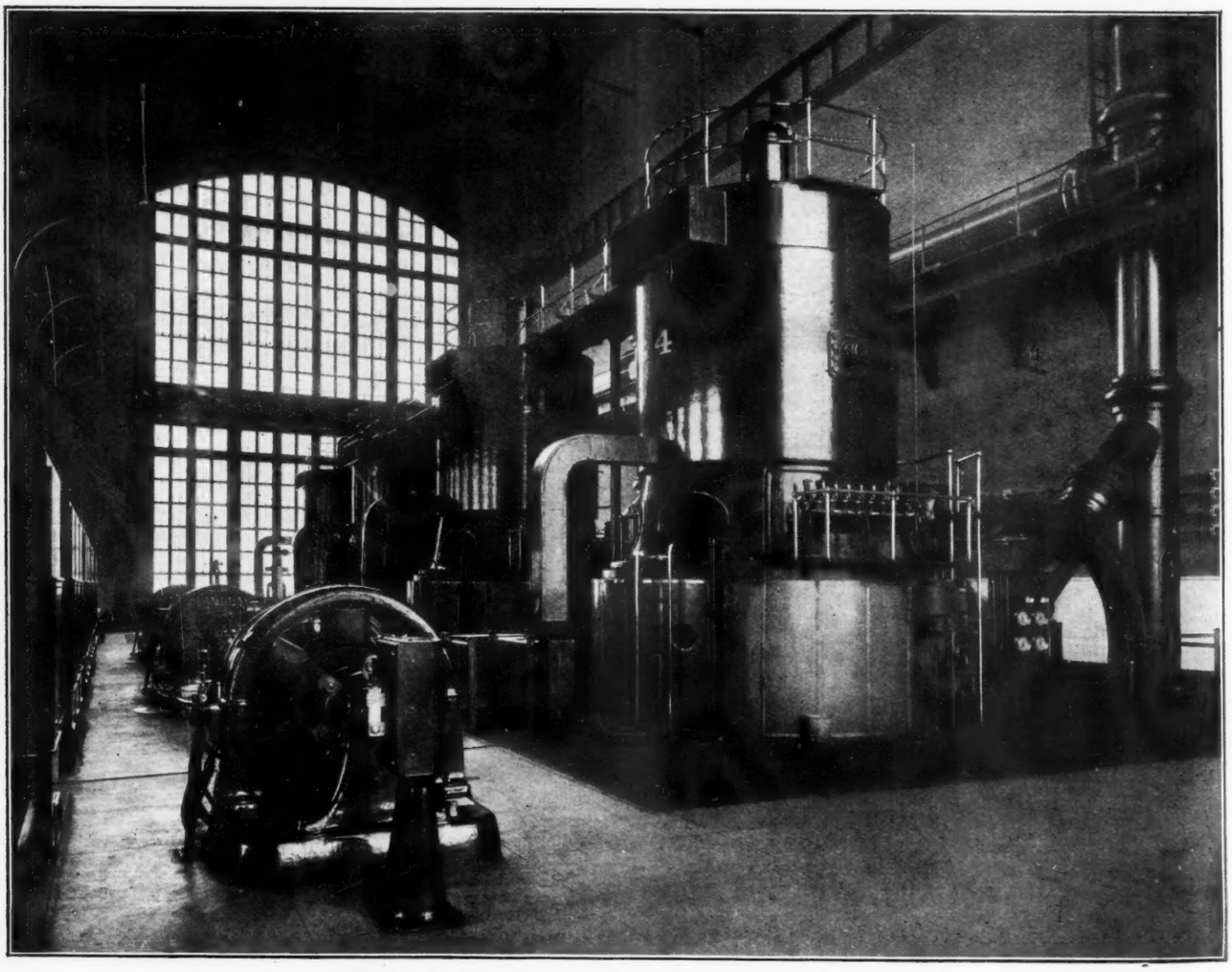


FIG. 1. TURBINE ROOM OF HUDSON-MANHATTAN PLANT

furnaces were reconstructed, as shown in Fig. 6. Each furnace has three arches, so spaced that the area between them is sufficient to allow the products of combustion to pass through under slight compression, and placed sufficiently high above the fire to allow the complete combustion of the gases before they are discharged through the openings between the arches upon the cold tubes.

The grate used is what is known as the McClave No. 4. It is arranged in front and rear sections, both of which dump toward the middle, so that the ashes, clinkers, etc., fall naturally into the center of the hopper, into which the ashpit is extended; see Fig. 3. This grate has been especially designed for the burning of small grades of anthracite, allowing the necessarily strong undergrate draft to be used without disarranging the fuel and throwing it about in ridges and mounds all over the surface of the fire bed. To this end it has a uniform mesh of ⅛ of an inch not only on the surface of each bar but also on the surface of the bars adjacent to the sides of the longitudinal carrying bars which span the space from the edge of the dead plate to the bridgewall.

The grate bars are made with sectional removable tops or caps, having ⅛-inch air space arranged as in Fig. 3. Into the shanks of these caps are cast soft-steel lugs which are bent under the bottom of the carrying bar, thus preventing any change in the location of the cap and insuring a uniform mesh all over the grate surface. The body portion of the bars is over 2 inches below the top level of the caps and is, therefore, not likely to warp or burn out from the fire on top of the grate. The bars overlap at their ends, as shown in Fig. 3, necessitating the use of the center tie *A* when the front and back of the grate dump in opposite directions. They may be brought into contact where they thus overlap, or an opening may be left between them by placing stops in front to arrest the throw of the stub levers at

FIG. 2. FRONT OF BOILERS WHICH ARE HAND FIRED

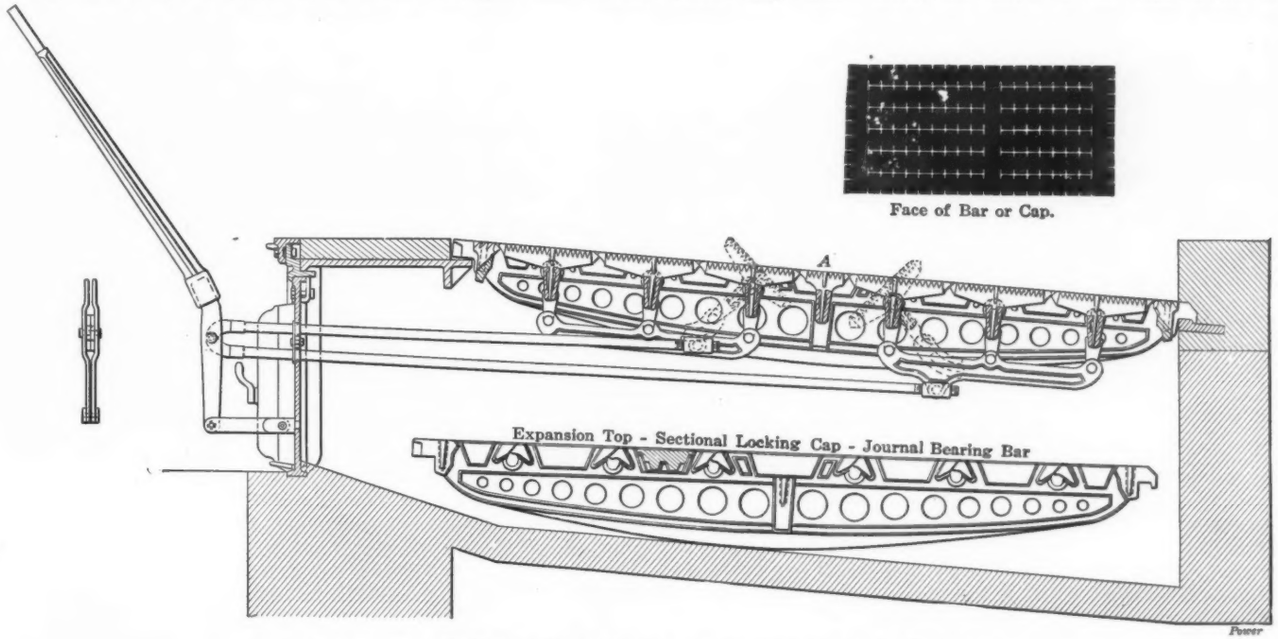


FIG. 3. THE MCCLAVE NO. 4 GRATE INSTALLED UNDER THE BOILERS

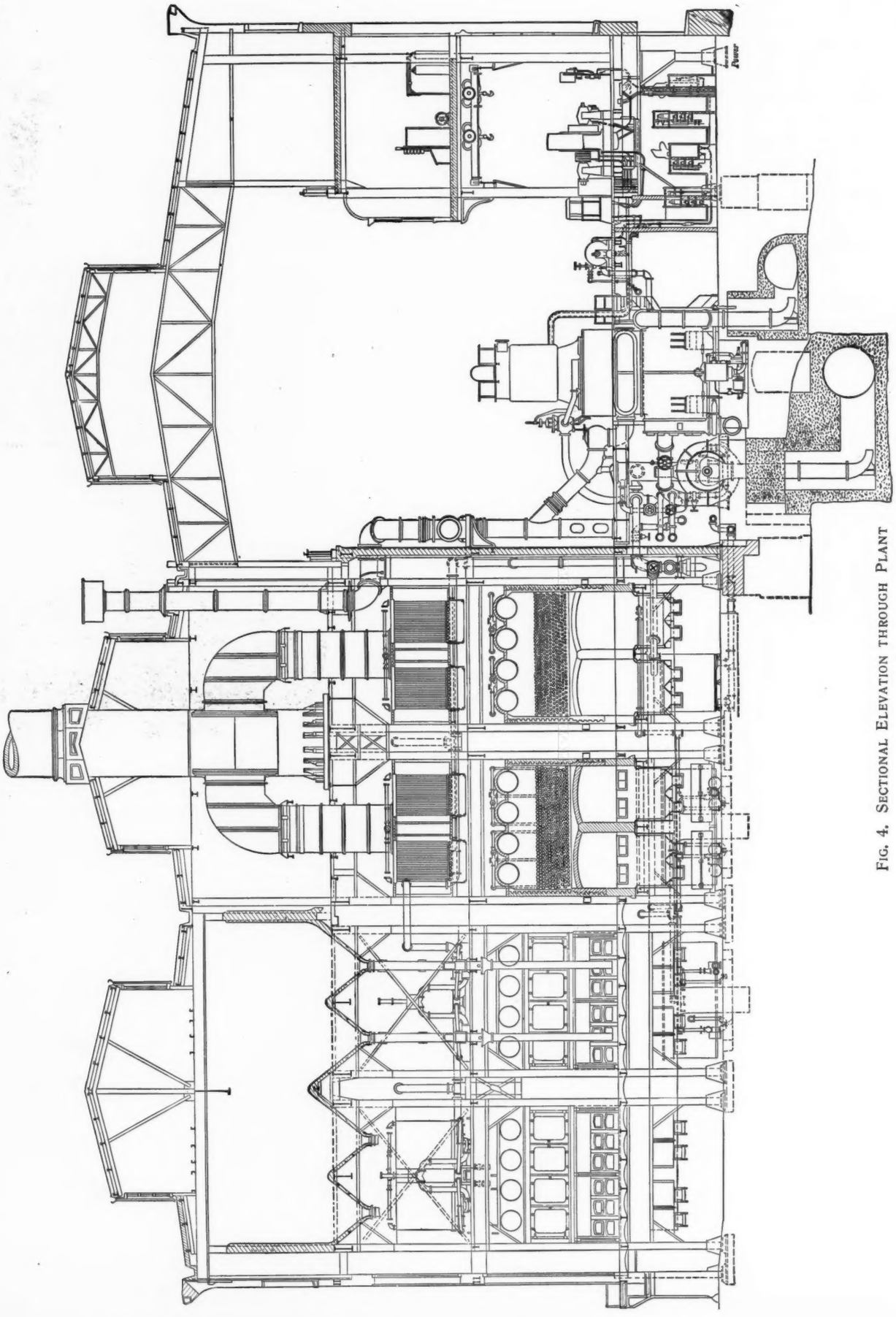


FIG. 4. SECTIONAL ELEVATION THROUGH PLANT

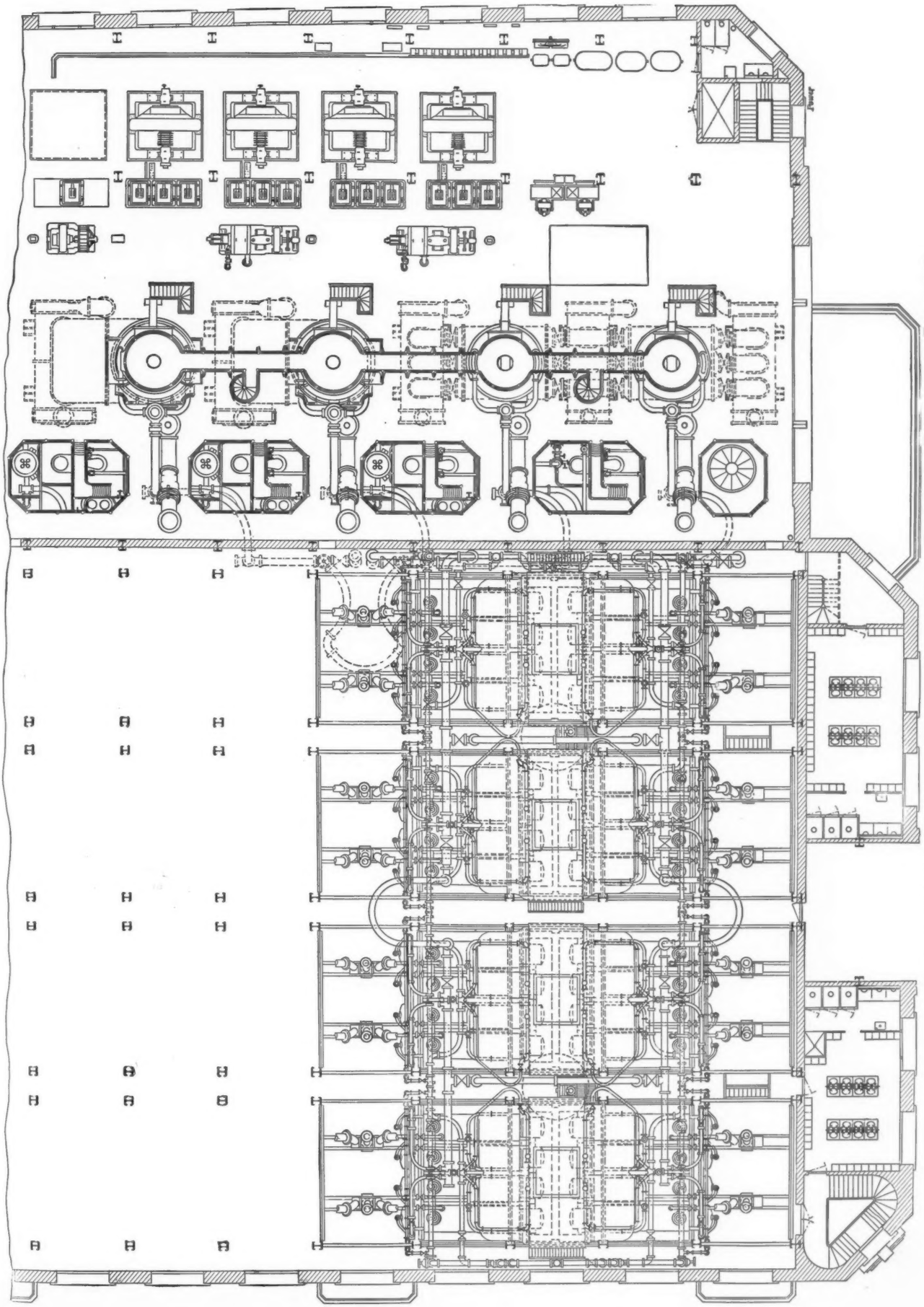


FIG. 5. PLAN VIEW OF PLANT, SHOWING ARRANGEMENT OF BOILERS AND TURBINE-ROOM EQUIPMENT

the right point to secure whatever space is desired.

The dead plate is protected with firebrick. The ledge on which the front edge of the grate rests is dropped several inches below the general level so that there may be always a considerable depth of fire at the front edge of the grate to resist the too liberal admission of air at this point without allowing the fuel to pile back into the doorways.

The grate is 10 feet in depth from the dead plate to the face of the bridgewall, made up as shown in Fig. 6 of five rows of bars dumping backward, the center tie and four rows of bars dumping forward. Each boiler is served by two furnaces separated by a division wall supporting the arches; each furnace being 10 feet deep by 9 feet 6 inches wide in the clear and having three sections of grates and three fire doors, as shown in Fig. 4.

When the fire is to be cleaned, the unconsumed fuel is pushed back onto the back half of the grate and the front half is dumped, after which the live coal is pulled forward onto the clean part and the rear section dumped. All of the unconsumed fuel is then distributed over the entire grate and fresh fuel added, all of which may be accomplished in less than two minutes. This is done separately for each furnace. Starting with this, perhaps 2 inches of live coal, the fires are allowed to build up until in the course of six to seven hours they will have attained a thickness of some 12 or 14 inches, two-thirds of which will be ash and only the top part live coal. The cleaning is done between the peaks. The air pressure used is from ½ to ⅝ inch of water in the ashpit with a light load, and with ⅛ inch suction in the furnace. After the fire gets to be 4 or 5 inches thick it is blown with about 2 inches of pressure in the ashpit, which gives a balanced condition in the furnace. When the fire is at its thickest a blast of 2½ inches is used. The average rate of combustion is 25 pounds per square foot of grate and the maximum 36 pounds. At this average rate of combustion they are able to carry the load with five boilers in active operation with one banked in reserve for emergency.

In the report of the Committee on Power Generation presented at the recent meeting of the American Interurban Rail-

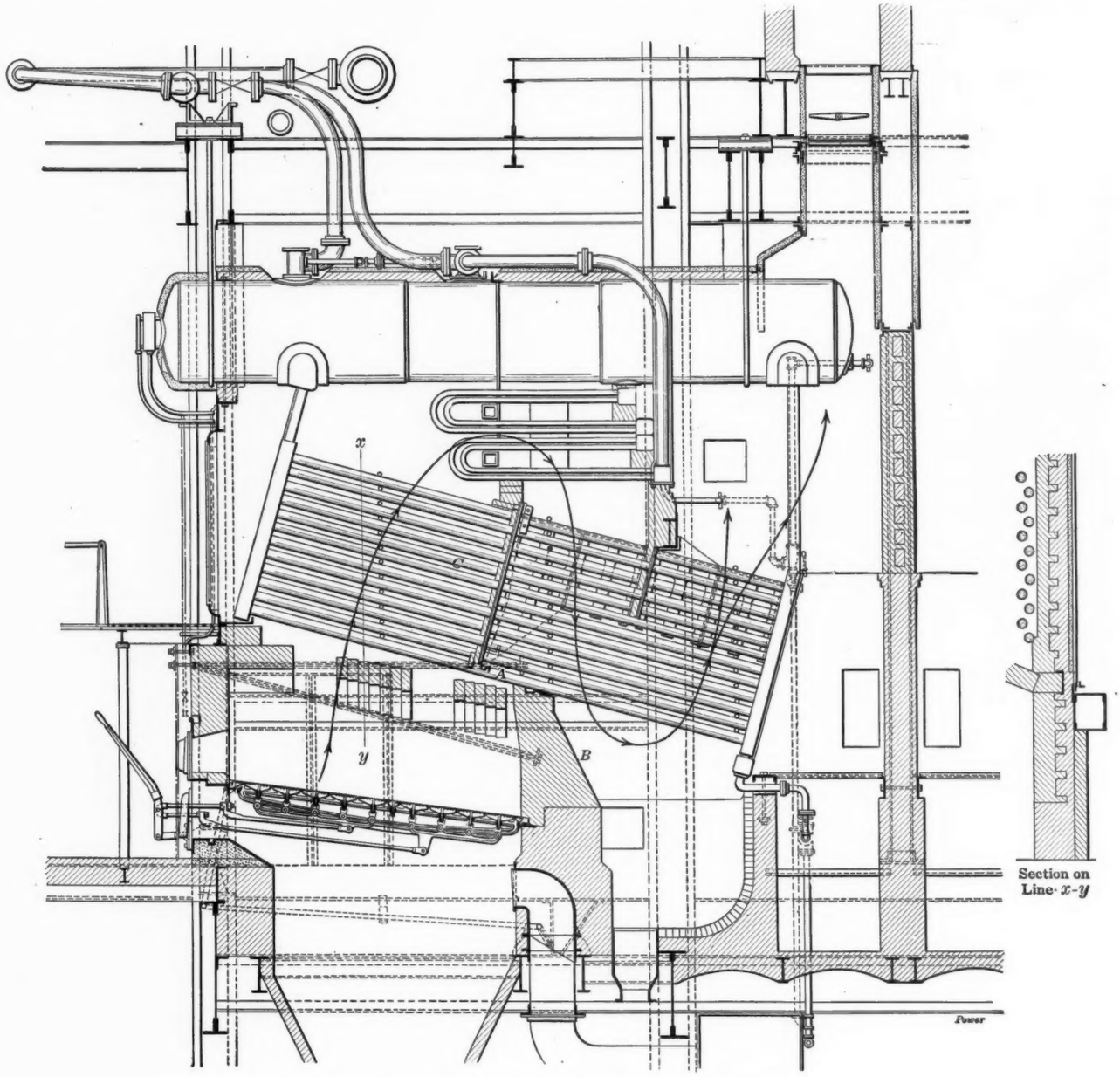


FIG. 6. VERTICAL SECTION THROUGH BOILER SETTING

way Engineering Association, C. E. Roehl mentioned the fact that practice is tending toward the reduction of the number of square feet of grate surface served by one fireman, and in turn increasing the rate of combustion which is expected of this fireman. In order to maintain a reasonable economy in the operation of a plant in which the hourly peak load is approximately two and a half times the average day load, it is absolutely necessary that the number of boilers in operation be kept down, so that the normal rating of the boilers will be approached during the light load of the middle day and night. Experience in this station shows that it is possible, roughly speaking, to obtain 1200 kilowatts from a fireman for a period not exceeding two and a half hours, and that the average fireman is as able to do this when shoveling this coal upon, say, 200 feet of grate surface as when shoveling the same amount of coal upon 100 square feet. It would, therefore, seem quite feasible to operate a boiler containing 200 square feet of grate surface with one man during the period of light loads, during which that man will develop, say, 700 kilowatts, and continue the same boiler in operation through the peak loads served by two firemen. During the peak load each of these men would have to work harder than the one alone during the light loads, as more than twice the light load output would be obtained by the two men, or 2400 kilowatts. At present, this practice is approached as nearly as operating conditions will permit and has proved quite effective, those of the surplus hands that it is nec-

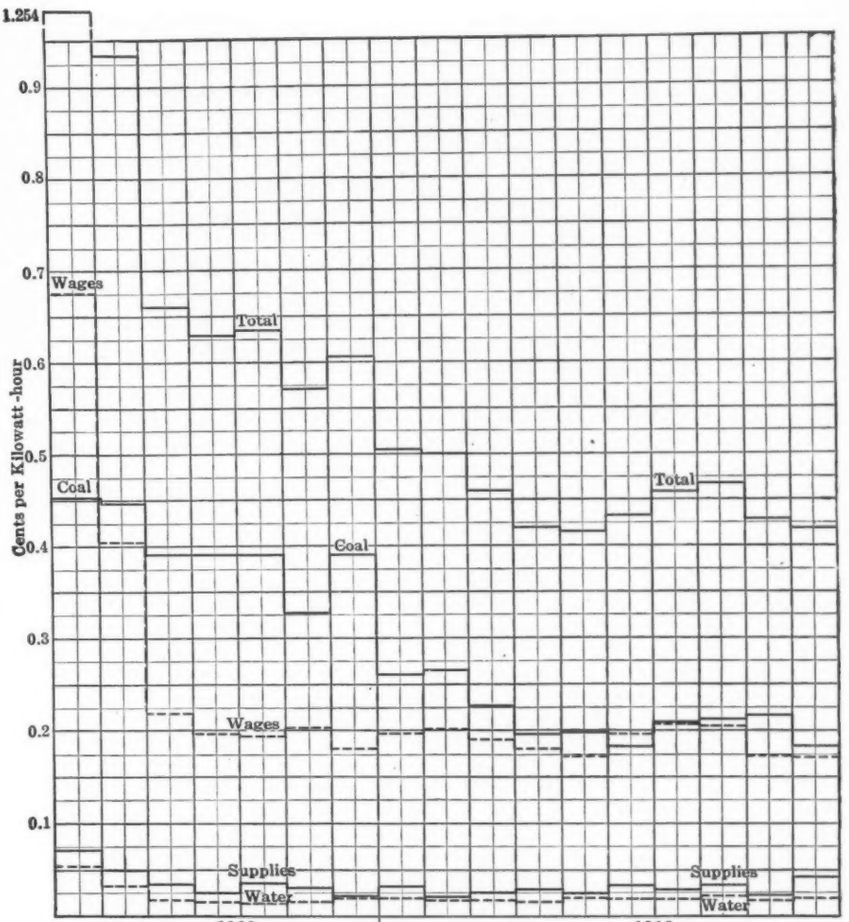


FIG. 7. COST OF POWER PER KILOWATT-HOUR

REPORT OF THREE TESTS OF A CERTAIN GRADE OF No. 3 BUCKWHEAT COAL BURNED UNDER A 900-HORSEPOWER BABCOCK & WILCOX BOILER, AT THE JERSEY CITY POWER HOUSE OF THE HUDSON-MANHATTAN RAILROAD COMPANY.

		Test No. 1	Test No. 2	Test No. 3			
1.	Date of test	June 22-23	July 5-8	July 20-21			
				1st Watch.	2d Watch.	3d Watch.	Total.
2.	Duration of test, hours	24	72	8	8	8	24
3.	Weight of coal as fired, lb.	114,600	305,500	44.237	38.600	30.400	113.237
4.	Percentage moisture in coal	4.6	2.75	.....	.....	.....	3.0
5.	Weights of dry coal, lb.	108,050	297,099	42,910	27,442	29,488	109,840
6.	Total ash and refuse, lb.	31,875	.....	10,000	11,250	9,375	30,625
7.	Percentage total ash and refuse in dry coal	29.5	21	22	29	30	27 Avg.
8.	Total combustible consumed, lb.	76,175	225,795	32,910	26,192	20,113	79,215
9.	Total weight of water fed to boiler, in pounds	687,294	1,897,413	299,796	276,706	213,248	789,750
10.	Equivalent water evaporated into dry steam from and at 212° F., lb. (including superheat)	741,590	2,087,154	326,178	304,099	230,307	860,584
11.	Factor of evaporation	1.079	1.1	1.088	1.099	1.080	1.089
	HOURLY QUANTITIES.						
12.	Dry coal consumed per hour, lb.	4502	4126	5364	4680	3686	4577 Avg.
13.	Dry coal consumed per square foot of grate surface per hour, lb.	23.7	21.7	28.2	24.7	19.3	24 Avg.
14.	Water evaporated per hour, lb.	28,637	26,353	37,474	34,588	26,656	32,906 Avg
15.	Equivalent evaporation per hour from and at 212°, lb.	30,899	28,988	40,772	38,012	28,788	35,857 Avg.
16.	Equivalent evaporation per hour from and at 212° F. per square foot of heating surface, lb.	3.38	3.17	4.46	4.17	3.16	3.93 Avg.
	AVERAGE PRESSURE, TEMPERATURES, ETC.						
17.	Steam pressure by gage, lb. per square inch	188	185	180	176	183	180
18.	Temperature of feed water	252	226.4	242	231	253	243
19.	Draft under grate in inches of water	0.5 to 1	0.5 to 1.75	0.625 to 1.5	1.625 to 2.5	0.5 to 1.375	
20.	Amount of superheat at boiler, very nearly	125°	125°	.....	.....	.....	125° Avg.
	HORSEPOWER.						
21.	Horsepower developed	901	840	1182	1102	834	1039
22.	Horsepower, builders' rating	900	900	900	900	.....	900
23.	Builders rating developed, per cent	100.1	93.3	132	122	93	114 Avg.
	ECONOMIC RESULTS.						
24.	Water apparently evaporated under actual conditions per pound of coal as fired	5.99	6.2	6.78	7.15	7.00	6.97
25.	Equivalent evaporation from and at 212° F. per lb. of coal as fired	6.47	6.82	7.37	7.85	7.56	7.59 Avg.
26.	Equivalent evaporation from and at 212° per lb of dry coal	6.86	7.02	7.60	8.12	7.81	7.84 Avg.
27.	Equivalent evaporation from and at 212° per lb. combustible	8.63	8.9	9.91	11.55	11.06	10.84 Avg.

essary to keep on during the periods of light load being used in cleaning fires and doing the odd jobs that can best be done at that time. In this way the services of the firemen are used at their utmost efficiency and, as the load increases, an extra fireman can be put on who will simply work the hours of peak loads, receiving extra compensation in return for his split watch. This will probably give a lower operating cost for the boiler room than having the extra fireman stay during the entire watch at his normal rate of wage, as he can waste more coal in the hours when his services are not needed than the extra compensation given him for his split watch.

The pressure carried is from 180 to 185 pounds with 125 degrees of superheat. Each boiler has a separate Green economizer which heats the feed water to 240 or 250 degrees. The water is passed first through closed heaters, supplied with steam from the auxiliaries, and there is also an open heater at work in the construction plant for which the station also supplies power from which a considerable quantity of hot water is returned.

In addition to the railroad load there are nine air compressors taking steam equivalent to about 1000 kilowatts. The turbines require 13.5 pounds of steam per kilowatt-hour of themselves, and 17.5 including the auxiliaries.

The cost of operation has been running down steadily since the plant was started, as shown by the chart in Fig. 7, and has reached the remarkably low figure of less than 0.42 of a cent per kilowatt-hour for current at the switchboard, including the cost of water, supplies, wages and coal. The No. 3 buckwheat costs about 43 per cent. less at the conveyer siding of the station than No. 1 buckwheat coal. One of the units is fitted with a Venturi meter, Richardson coal scales, Westover CO_2 recorder, etc., and produced upon test the results in the accompanying table, the test being made with No. 3 buckwheat and with the alternate method of starting and stopping, as recommended by the Boiler Testing Code Committee of the American Society of Mechanical Engineers.

For the data and information contained in this article we are indebted to E. T. Munger, general manager of the Hudson & Manhattan Railroad Company.

Vacuum for Reciprocating Engines

In a paper read before the Northeast Coast Institution of Engineers and Shipbuilders on November 25, D. B. Morison, whose words upon the subject of condensers have come to have more than ordinary importance, attributed the usual practice of carrying a low vacuum with triple- and quadruple-expansion marine engines to the fact that it produced a high temperature of air-pump discharge water. This practice is associated with the assumption that any vacuum above 25 inches in the condenser is a source of waste, while a few inches less works no difference as the feed water becomes just so much hotter.

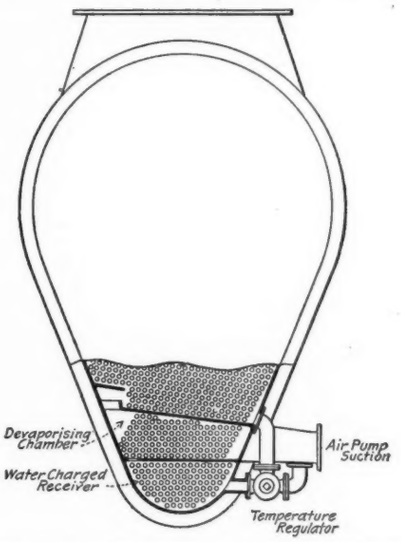
In a recent paper upon the economical working of reciprocating marine engines, Mr. Morison contends that it is advantageous to run at as high a vacuum as possible. Mr. Weir takes issue with this assertion and places the maximum economical vacuum at 25 inches with triple- and quadruple-expansion marine engines.

In support of the contention that the power increases and the steam consumption per brake horsepower decreases with approximate uniformity up to the highest vacuum that can be reasonably carried on a steamship, Mr. Morison quoted the result of some investigations by Mr. Willans which showed that with a central-valve compound engine, the consumption per brake horsepower decreased with an increase of vacuum, at the rate of 1 per cent. per inch up to 27 inches vacuum. Referring to land practice, tests by Messrs. Belliss and Morcom showed that in a triple-expansion high-speed engine, the increase in steam consumption per brake horsepower was at the rate of 1.77 per cent. per inch of decrease in vacuum, from 28 inches down to 21.5 inches.

It was pointed out that the first essential in any condenser is a disposition of the surfaces such as will result in the greatest over-all efficiency; but the mere fact that a condenser has a large surface per horsepower is no criterion of its condensing capacity, because much of this may be ineffective. It is the treatment of the air in a condenser which is so vital to its efficiency, and from this point of view that condenser is the best which provides the air pump with air at maximum density.

Air-pump efficiency is a governing factor in any condensing plant, and in ordinary reciprocating engines the quantity of air leaking into the system is considerable. Tropical sea water also has a highly prejudicial effect on air-pump capacity by reason of the smaller difernce in temperature of the water flowing through the tubes and that of the aërated vapor outside the tubes in the lower part of the condenser. This fact is largely responsible for the great fall in vacuum that invariably takes place in the tropics. Marine engineers accept its evil consequences as inevitable; but they are by no means inevitable, and can be overcome in an extremely simple manner. Many steamships trading in the tropics cannot carry more than 20 to 22 inches vacuum; but if the condensers were designed to carry 27 inches vacuum in the tropics and the engines were properly proportioned, together with adequate arrangements for feed-water heating, the saving would amount to about 10 per cent.

The air-withdrawing capacity of any reciprocating air pump depends upon the difference between the vacuum that can be produced in the pump barrel on its suction stroke and the vacuum in the condenser. It would obviously boil as soon as the pump buckets commenced the suction stroke, and the resultant vapor would impair the inflow of air from the condenser. Therefore, an air pump can be rendered flexible in air-withdrawing capacity by regulating the temperature.



SECTION OF CONDENSER, SHOWING WATER RECEIVER AND DIAPHRAGM

There are several devices on the market for accomplishing this. The condenser herein illustrated contains a divided receiver in its base, which is al-

ways completely filled with water of condensation. At a distance above this water receiver is a diaphragm which catches the water of condensation formed in the condensing chamber above it. There is a pipe connecting the top of the water-collecting diaphragm and water receiver, and in the pipe there is inserted a two-way cock; one way leads to the air-pump suction pipe and the other to the water receiver. If there is a clear way between the water-collecting diaphragm and the water receiver, all the water of condensation passes through the receiver and is reduced in temperature before it passes into the air pump. If, on the other hand, there is a clear way between the collecting diaphragm and the pump, all the water of condensation passes at a maximum temperature into the pump. The temperature of the pump and, therefore, its air-withdrawing capacity, is under complete control by the partial or full use of the temperature regulator. An extended experience has demonstrated that this simple apparatus will raise the vacuum in the tropics from 1½ to 3 inches, and often more, depending upon the amount of air prevailing; at the same time the air-pump discharge water is kept at the highest temperature consistent with the maintenance of the highest available vacuum in the condenser.

The air pump will withdraw air in maximum quantity only when the condenser delivers that air to it as free as possible from water vapor; therefore the interdependence of an air pump and condenser is obvious. The action of the one so influences the action of the other that both must be correctly designed if the available results must be realized.

Feed water in any steamship can be heated to the pumping limit by the available auxiliary exhaust steam, so that to ignore the economical possibilities of a high vacuum in the main engine and to work at a low vacuum in the condenser, with the sole object of obtaining a high temperature of air-pump discharge water, and then to throw away heat by deliberately discharging exhaust steam into the condenser because the feed water is already too hot to absorb it, is a system that involves considerable loss to the ship owner throughout the life of a ship.

Mr. Weir's Reply

In the December 9 number of *Engineering*, W. Weir takes issue with Mr. Morison, stating that after a careful perusal of the results of Mr. Willans' investigation he was unable to find any evidence that in a marine engine the steam consumption per brake horsepower decreases at the rate of 1 per cent. per inch of vacuum over 25 inches. Furthermore, Messrs. Belliss and Morcoms' figures show that from 21.5 to 25 inches the total economy was 1.3 pounds, or 2.8 per cent. per inch, while from 25 to 27.9 inches, the total economy was 0.3 pound, equivalent to 0.78 per cent. per inch—a very notable difference. He also charges an important omission in considering these latter figures in the fact that the reader is left to assume that the figures given represent the actual difference in economy, whereas they must be corrected for the cost of obtaining the relatively high degree of vacuum.

As regards the power required for the air pump, this can be omitted, as it will be practically the same for a 25-inch vacuum as for 28 inches; but for the latter condition, twice as much circulating water must be pumped as for the former. Figures are quoted to show that with the best type of high-speed engine for utilizing low terminal pressures, the actual saving in water consumption with vacuums over 25 inches may be 1.47 per cent. as a maximum. This, however, is more than counterbalanced by the extra power required for circulating water, together with the thermal loss due to the low hotwell temperature. A hotwell temperature of 124 degrees associated with a vacuum of 25 inches easily prevents the absorption by the feed water of all the steam from the auxiliary apparatus in the plant.

Features of Plant at Kodak Park Works

By A. R. Maujer

The features of the plant at Kodak Park works which are of more than ordinary interest are tallest chimney in New York State, motor-driven boiler-feed pumps and a system of oil storage which reduces the waste of oil to the minimum.

The large steam-power plant which serves the great manufactory, Kodak Park Works, of the Eastman Kodak Company, located at Rochester, N. Y., where photographic film, paper and dry plates are manufactured, possesses some features of more than passing interest.

Chimney

Perhaps the most conspicuous object about any steam-power plant is the chimney. In this instance the chimney is especially conspicuous due to its great hight and fine design. It is 366 feet high, the tallest chimney in New York State. The object in making the chimney so high was, not so much to secure a strong draft as to carry off the acid fumes from the plate-coating departments and discharge them into the atmosphere at such a hight that they become well diffused before they can sink back to the ground level. The chimney is built of radial brick and contains an acid-proof brick lining throughout its entire hight. The inside diameter of the chimney is 9 feet. The present boiler capacity is approximately 5000 horsepower. Owing to an enlargement of the works an addition of about 3000 horsepower is to be made to the boiler equipment. To take care of this additional boiler capacity another chimney of the same hight but having an inside diameter of 13 feet has just been completed. This increases the capacity by 125 per cent. Both chimneys were erected by the Alphons Custodis Chimney Construction Company.

Electrically Driven Boiler-feed Pumps

Another interesting feature is the two electrically driven boiler-feed pumps. The pumps are of the Deming triplex single-acting type. The larger one is 9x10 inches in size and the smaller one, 7x8 inches. The speed at which they run varies from 20 to 40 revolutions per minute; under normal conditions they operate at speeds of 25 and 30 revolutions per minute respectively. The larger pump is driven by a 35-horsepower Three Rivers Electric Company motor; the smaller one is driven by a 16-horsepower Rochester Electric Company motor. The pumps are designed with a double gear-and-pinion drive which tends to make the torsion in the crank shaft uniform and cause the pumps to run smoothly and efficiently. The motors have field control for varying the speed. The ratio of variation is 2 to 1. The pumps are provided with relief valves on the discharge pipes having outlet to the floor. When a rise in pressure causes the relief valves to open and thus indicate that there is trouble somewhere in the system, the discharge of water onto the boiler-room floor quickly attracts attention and the pumps are slowed down. The pumps have just been fitted with automatic pressure-regulated electric controllers so that the speed of the motors will be regulated according to the pressure. A set of steam pumps having the same capacity as the electrically driven pumps is maintained as an emergency equipment.

The smaller of the electrically driven pumps has been in continuous service for three and one-half years and the larger one for two. During these periods neither has gone out of service through accident or sudden failure. The average temperature of the water handled

by the pumps is 210 degrees Fahrenheit; the boiler pressure against which they pump is 140 pounds. After passing through the pumps, the feed water goes through economizers and thence to the boilers. The larger of these pumps was illustrated in the September 27, 1910, issue of POWER.

FIG. 1. OIL-STORAGE VAULT

OIL-STORAGE SYSTEM

Opening into the engine room is a brick and tile-lined vault which contains six self-measuring oil tanks manufactured by S. F. Bowser & Co. A view of the interior of the vault is given in Fig. 1. The vault is kept locked and oil may be obtained only by presenting a written order from the head of a department. Some such arrangement is highly desirable in a plant of this size and type where there are numerous departments in which various oils are used. If a rather close check were not maintained, the yearly expense for oil would undoubtedly be far above what it reasonably should be.

Each month a report is made out on a card of the form shown herewith. Thus the consumption of each department for each montn is placed on record in a convenient manner.

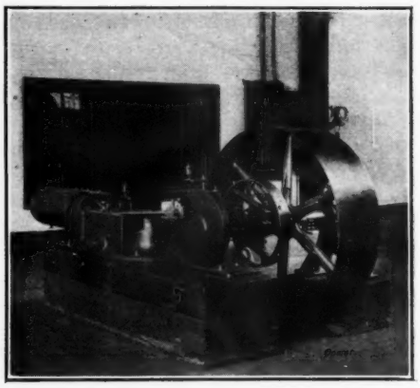


FIG. 3. THE ORIGINAL EQUIPMENT

The arrangement of the tanks in the storage vault is convenient for filling the tanks and drawing the supplies. A barrel is rolled onto the cradle which is hinged to the barrel track. A tackle suspended from the ceiling is attached to the ring in the cradle, the end of the cradle is hoisted up and the barrel rolled off onto the track and around to the proper tank into which it is emptied through the manhole.

Oil is drawn from the tank by a plunger hand pump. One full stroke of the plunger discharges one gallon from the spout. A rod alongside of the plunger rod carries a number of adjustable stops. By turning this rod so that when the plunger is lifted, a projection on the

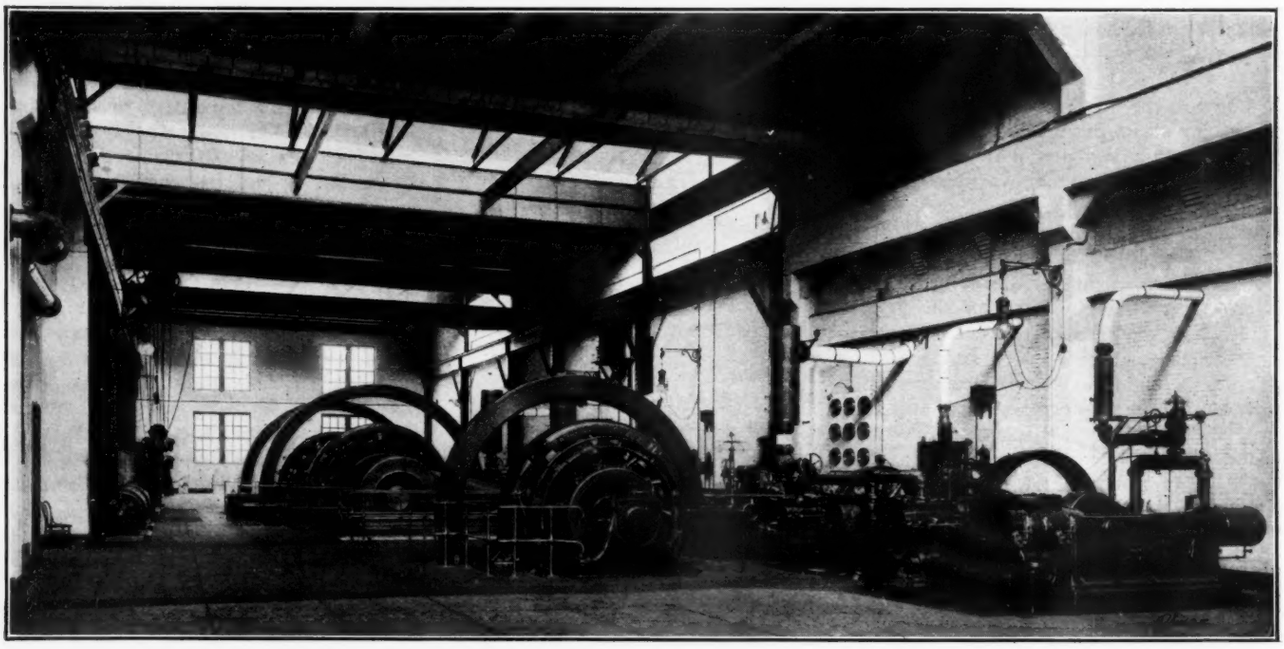


FIG. 2. VIEW OF GENERATING ROOM, SHOWING PRESENT EQUIPMENT

plunger-rod comes in contact with a given stop, the stroke of the plunger is limited and only a given fraction of a gallon is discharged. A registering device at the side of the pumping mechanism records the number of gallons successfully drawn.

A marked metal gage rod is provided in each tank so that the amount of oil still remaining in the tank can easily be ascertained at any time. Each tank has a capacity of 280 gallons. Two tanks contain cylinder oil, two contain engine oil, one contains kerosene and one, oil for the ice machines.

Original and Present Equipment

A general view of the engine room is shown in Fig. 2. The present equipment consists of two 500-kilowatt Crocker-Wheeler generators direct connected to Rice & Sargent Corliss engines, one generator of the same make but of 300 kilowatts capacity driven by an Allis-Chalmers Reliance engine and two Ingersoll-Rand duplex two-stage air compressors, one having a capacity of 530 cubic feet of free air per minute, the other, 710 cubic feet.

Because of the increase in the amount of power required, the capacity of the present equipment will be increased by the installation of a 1000-kilowatt generating unit, built by the Crocker-Wheeler Company. This unit will be driven by a 31 and 48 by 48-inch horizontal cross-compound noncondensing Corliss engine built by the Robert Wetherill Company.

In a separate building there are two York compression and six Isbell-Porter absorption ice machines of a combined capacity of 1920 tons per 24 hours. The refrigerating equipment will be increased by the installation of one 400-ton York compression machine, furnished by the York Manufacturing Company.

A relic of the small beginnings from which the present vast plant has grown is present in the engine room In the shape of the first steam engine used by George Eastman in the manufacture of cameras and supplies. The engine is shown in Fig. 3. It is 8 by 14 inches in size and ran at 275 revolutions per minute. The engine was built by the Buckeye Engine Company about 1885. It was used continuously until two or three years ago.

Some Testimonial Letters

More or less importance is credited to testimonial letters, according to the knowledge the reader has of how they were procured. Usually the party desiring a letter of this sort makes the request from several users of the device in question, and naturally selects the best for publication.

Some of these letters are indeed humorous when the literal meaning is taken. For instance, a certain water-purifying company recently sent out carbon copies of letters from satisfied users of their filter.

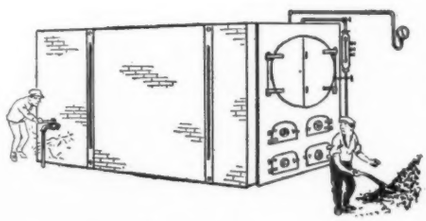


Fig. 1. Loose Scale Did Stunts in the Blowoff Pipe

One engineer writes in part as follows:

"No compound has been put in the boilers since water from the filter was turned on. The boilers were blown off twice a day as required and we could hear the scale rattling out the blowoff pipe."

It certainly looks as if the boiler had better be opened and cleaned, for if there is enough free scale in it to attract the engineer's attention as it passes through the blowoff pipe, it is about time the scale was removed by other methods.

Another engineer, since using the filtered water, states that "The boilers steam now in nine and a quarter against forty-five minutes before."

Getting up steam in forty-five minutes is going some, but generating steam in nine and a quarter minutes is a record and certainly speaks well for the filter.

Be careful how you read them. Don't jump at conclusions. The literal translation is frequently absurd.

How about the boiler seams and tube heads?

Further on the same engineer says, "The purifier has accomplished everything claimed by them. It works automatically and requires no attention. We are now using water for drinking and washing purposes in our office and plant."

It is difficult to determine just what is meant by the above. Whether it is the purifier or the manufacturer that makes the claims, is not quite clear. The letter says it's the filter, but it must be a kind of filtered testimony.

The third sentence is enough to overcome the equilibrium of most readers,

Fig. 2. Used Real Water for Drinking and Washing Purposes

and cause them to wonder what liquid was used for drinking and washing purposes before the filter was installed. Most of us know that in breweries, Milwaukee and Cincinnati, water for drinking purposes is almost an unknown quantity, but it is not generally known that washing is performed with any other liquid than water. Oh, well, everyone to his own taste.

Still another engineer makes the following wonderful statement as to the results obtained from using filtered water:

"Never before had I seen the tubes of my boilers and shell as clean. Just nine and a quarter minutes after lighting the fire this boiler blew the safety valve off."

Nothing is said as to where the valve landed or how far it was blown. Truly these testimonials are most remarkable and convincing.

If there was anything under the sun which seemed to defy the old trite saying that there is a use for everything if you can only find it, it was the sudd of the Nile, that dense vegetable growth which is the continual bugbear of the Nile engineer and navigator. But now all that is to be changed; sudd is to become a commodity instead of a nuisance, and in time to come we may see its price rising in the market just as that of petroleum refuse rose when means of using it profitably as a fuel were found. What is to happen to the sudd is that it is to be conveyed to suitable machinery in which it will be dried, disintegrated and compressed into briquets suitable for consumption in steam boilers, in which it is expected to give an evaporation of about 4¾ pounds of water per pound of briquet. When it is recalled that the present price of coal in Khartum is about $15 a ton, the possibilities of the new fuel are apparent. Experiments on a comparatively small scale have so far only been made, but there seems little doubt that in a short time sudd-briquet factories will be established on the banks of the Nile, and that the 35,000 square miles of sudd will become an Egyptian asset instead of an unmitigated nuisance. —*Exchange.*

Engine and Compressor Power Charts

By T. M. Chance

A graphic method of quickly determining the required dimensions for a given power, or vice versa, of a steam engine, gas engine or air compressor.

One of the most frequent calculations made by mechanical engineers is the horsepower of engines and compressors. When rough estimates of the power delivered by an engine of certain dimensions are hurriedly made, errors often occur from the improper use of the formulas or quantities under consideration. For example, it often happens that the number of revolutions is used as the value of the quantity N in the formula

$$\frac{PLAN}{33{,}000}$$

instead of the number of strokes per minute, and in a double-acting engine this gives a result only one-half as large as

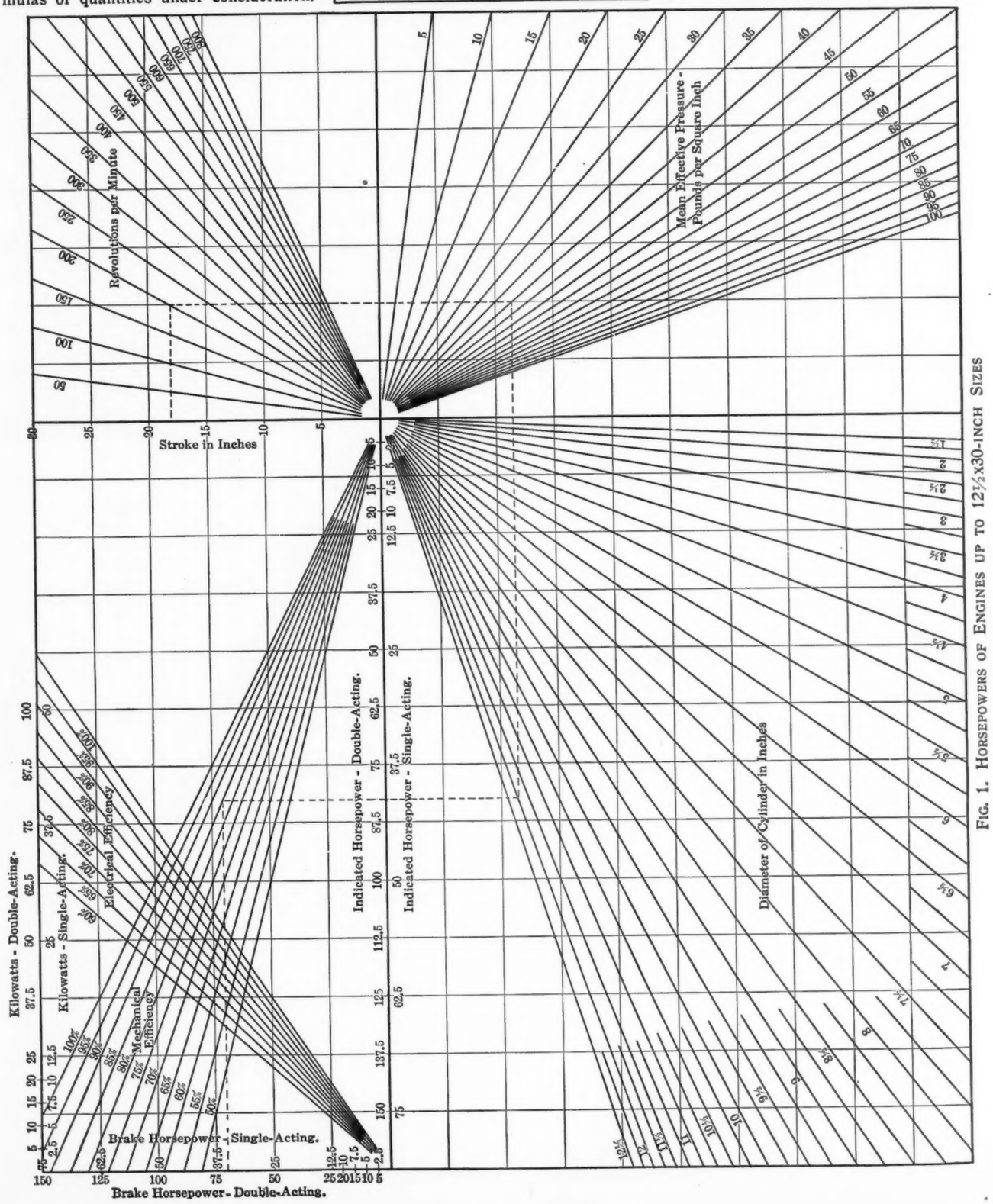


FIG. 1. HORSEPOWERS OF ENGINES UP TO 12½x30-INCH SIZES

that which should be obtained. Similar errors, as well as arithmetical inaccuracies not due to ignorance, are of common occurrence and may lead to large discrepancies in the subsequent result. It occurred to the writer that if a curve, or a series of curves, could be devised which would show at a glance the indicated brake and electrical output of an engine of any size, stroke, mean effective pressure and revolutions per minute, it would be exceedingly convenient and useful to engineers.

In the accompanying diagrams the horsepower rating is based upon the formula

$$\frac{PLAN}{33{,}000} = I.h.p.$$

Where,

P = Mean effective pressure in pounds per square inch;

L = Stroke in feet;

A = Area of the piston in square inches;

N = Number of strokes per minute (twice the number of revolutions).

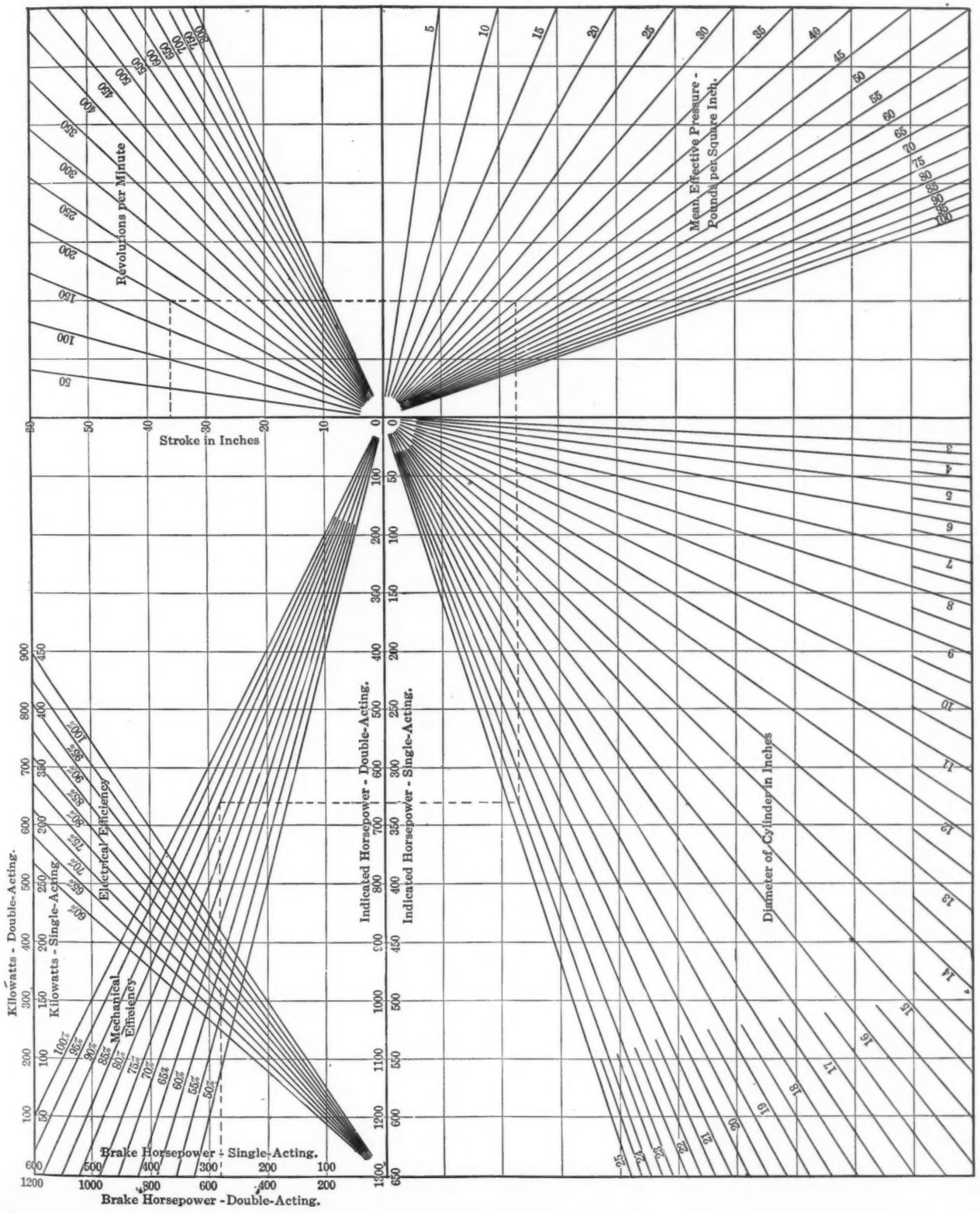


FIG. 2. HORSEPOWERS OF ENGINES UP TO 25x60-INCH SIZES

and,

I.h.p. $\times$ m = Brake horsepower;

B.h.p. $\times$ e = Kilowatt rating;

where,

m = Mechanical efficiency of the engine,

e = Total efficiency of the generator.

In the diagrams the stroke of the engine is laid off in inches instead of feet, and the diameter is similarly measured, the inch being the most convenient unit for this purpose. It should be noted that the horsepower varies directly with the area of the cylinder, that is, as the square of the diameter; hence, the diameters must be spaced proportionately to their squares, since they graphically represent the areas of the cylinders.

For the sake of accuracy in the smaller powers, the diagram has been prepared on three scales; Fig. 1 is to be used for engines up to 12½ inches cylinder diameter and 30-inch stroke; Fig. 2 includes engines up to 25 inches cylinder diameter and 60-inch stroke, and Fig. 3 deals with engines up to 50 inches cylinder diameter.

Referring to Fig. 1, suppose it is required to compute the horsepower of a 12x18-inch engine working under 40 pounds mean effective pressure and run-

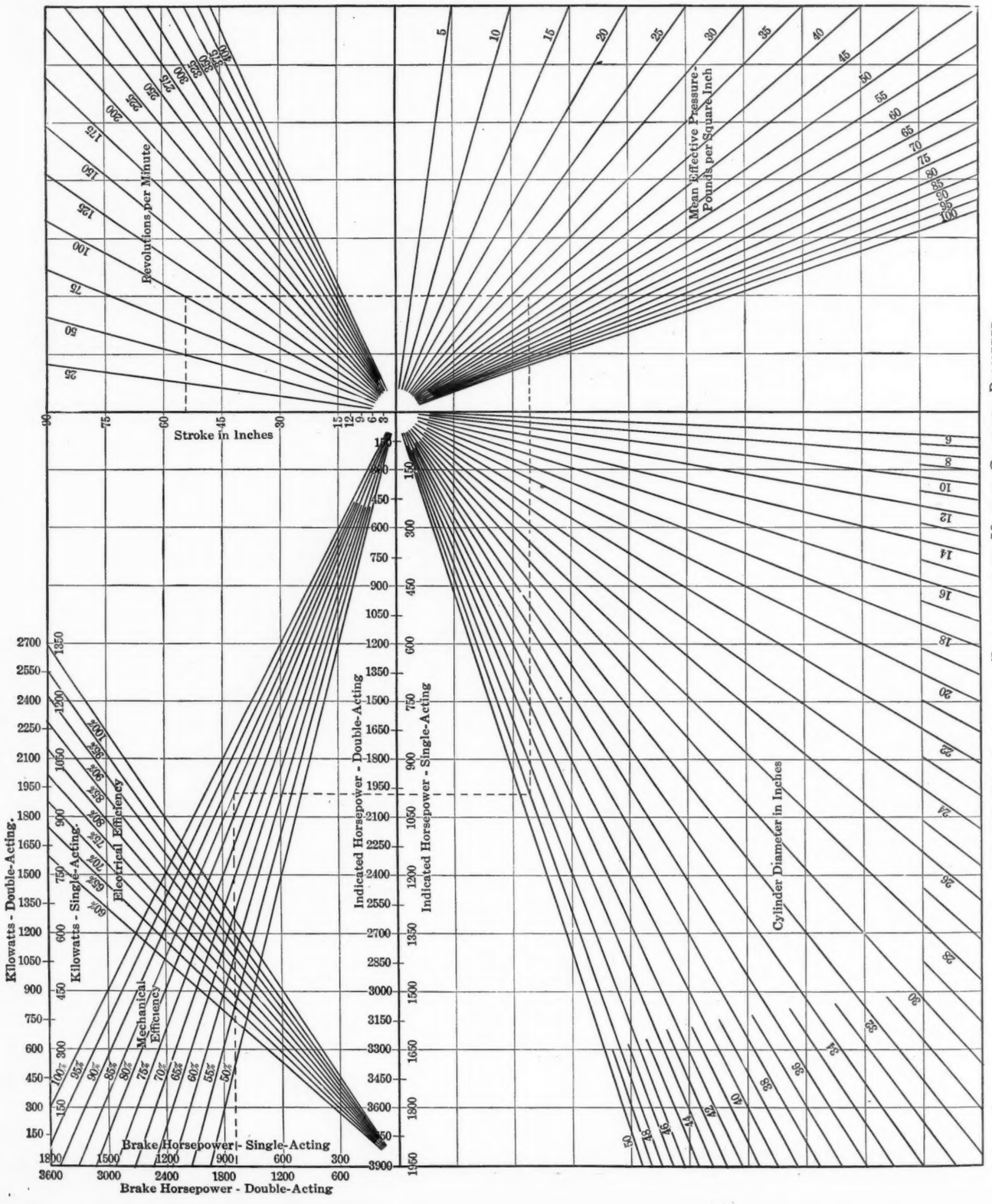


FIG. 3. HORSEPOWERS OF ENGINES UP TO 50-INCH CYLINDER DIAMETER

ning at 200 revolutions per minute, the dotted line indicates the steps taken in the solution of the problem. Reading up the scale of "Stroke in Inches" to 18 inches, follow horizontally across to the intersection of this line with the diagonal line marked 200 on the scale of "Revolutions per Minute"; from this intersection drop vertically downward until the diagonal line marked 40 on the scale of "Mean Effective Pressures" is crossed; follow horizontally across from this point to the line marked 12 inches on the "Diameter in Inches" scale and, running vertically upward from this intersection to the scale of "Indicated Horsepower, Double Acting," the result is found to be 82.5 indicated horsepower. If it is desired to find the horsepower of the engine running single acting, it will be found to read 41.25 indicated horsepower on the lower scale of "Indicated Horsepower, Single Acting."

If the brake horsepower and kilowatt capacity of the engine is desired, assuming 85 per cent. mechanical efficiency and 95 per cent. generator efficiency, read vertically upward along the 82.5 indicated horsepower line to its intersection with the diagonal line marked 85 per cent. on the scale of "Mechanical Efficiency"; the horizontal line passing through this point shows the brake horsepower to be 70 on the scale marked "Brake Horsepower, Double Acting." To determine the electrical output, follow vertically upward from the intersection of this horizontal line with the line passing through 95 per cent. on the scale of "Electrical Efficiency" and read 50 kilowatts on the scale marked "Kilowatts, Double Acting." The same use may be made of the single-acting scales for the brake horsepower and kilowatts output as was done in the case of the indicated horsepower.

Where refinement in the calculations is desired, the decrease in power due to the reduction in effective area of the piston on account of the piston rod and tail rod, if the latter is used, must be computed. This is easily done with these diagrams by considering the piston rod and tail rod as two single-acting engines, having a cylinder diameter equal to that of the rods and working in opposition to the engine. When the piston rod and tail rod are of the same diameter they may be considered as one engine, running double acting. Therefore, if the decrease in power caused by the piston rod of a 100-brake horsepower engine amounted to 2 brake horsepower, the actual brake horsepower delivered by the engine would be 98.

The diagrams are also useful in calculating compressor dimensions. For example, a compressor is to be installed to develop 660 indicated horsepower; the stroke of the compressor is 36 inches, the mean effective pressure 40 pounds, and the diameter of the cylinder 24 inches; find the number of revolutions. The dotted line in Fig. 2 indicates the steps taken in the solution of this problem. Starting with 660 on the scale of "Indicated Horsepower, Double Acting," drop vertically downward to the diagonal line marked 24 on the scale of "Cylinder Diameter in Inches." From this intersection follow horizontally across to the diagonal line marked 40 on the scale of "Mean Effective Pressures" and from this point run vertically upward to the intersection with the horizontal line passing through 36 inches on the scale of "Stroke in Inches." A diagonal line passing through this intersection and the common center of all the diagonal lines gives the number of revolutions, on the scale of "Revolutions per Minute," which in this case is 200.

The diagram may also be used to directly calculate the dimensions and power of gas or oil engines, if of the two-stroke type, as the horsepower of engines of this type is computed by the same formula as that used in steam-engine calculations; hence,

$$I.h.p. = \frac{PLAN}{33{,}000}, \text{ for double-acting engines}$$

$$I.h.p. = \frac{PLAN}{33{,}000 \times 2} \text{ for single-acting engines}$$

In the case of four-stroke engines the result obtained by the use of the diagram must be divided by two, as the four-stroke engine receives but half as many impulses as the two-stroke machine, during the same number of revolutions; that is,

$$I.h.p. = \frac{PLAN}{33{,}000 \times 2} \text{ for double-acting engines}$$

$$I.h.p. = \frac{PLAN}{33{,}000 \times 4} \text{ for single-acting engines}$$

When determining the dimensions of a four-stroke engine it should be remembered that the principal dimensions of a four-stroke engine and those of a two-stroke engine of twice the power are identical; hence, read twice the power of the machine under consideration on the horsepower or kilowatt scales and proceed as if the dimensions of a two-stroke engine of that power were being computed. The dotted line in Fig. 3 represent the procedure in the calculation of the dimensions or power of both a two-stroke engine of 1980 horsepower and a four-stroke engine of 990 horsepower.

Weighing Small Parts Accurately

By S. Kirlin

In machine shops, as well as in many other places, it is frequently desired to ascertain the exact weight of small pieces of castings, etc., and with the ordinary kind of platform scales generally used in these places it is impossible to weigh anything less than 5 or 10 pounds with any degree of accuracy. In machine shops especially, where the scales are used for weighing pig iron, heavy castings and subjected to the rough treatment usually given to them, it is practically impossible to weigh anything less than five pounds accurately.

Here is a method by which small parts weighing from a fraction of a pound up to several pounds may be weighed with extreme accuracy on almost any size of scales.

Slide the weight on the scale beam back to 0 and remove the weights from the beam in the same manner as when "balancing" them. Now, hang the small piece that is to be weighed on the end of the beam from which the weights were removed; next pile enough iron, or any other heavy material, on the platform until it just balances the small piece on the end of the beam. Now remove the small piece from the end of the beam and weigh the iron on the platform in the usual manner; divide this weight by the "ratio" of the scale and the product will be the exact weight of the small piece.

The "ratio" of the ordinary small platform scales is usually 100 to 1; that is, a weight of one pound on the end of the scale beam will just be balanced by a weight of 100 pounds on the platform. This ratio on larger scales may be 200 to 1 or greater.

Example: Suppose there is a small piece to be weighed; first remove the weights from the end of the scale beam, slide the weight on the beam scale back to 0 and see that the scales "balance." Now hang the small piece on the end of the beam from which the weights were removed and pile enough scrap iron on the platform to just balance the small piece. If the iron on the platform is found to weigh 175 pounds and the ratio of the scales is 100 to 1, then divide this 175 pounds by 100 and obtain 1.75 as the weight of the small piece. If the ratio of the scale was 200 to 1 it is obvious that it would have been necessary to place double the weight on the platform to balance the small piece. In this case there would have been a weight of 350 pounds, which divided by 200 gives 1.75 as the weight of the small part. This is extremely accurate even though the scales may be far from accurate in weighing anything less than 10 pounds in the ordinary manner.

I hear someone ask how you would go about it to find the ratio of the scales in case you did not know what it was.

This is easy. If you live east of the Missouri river, just lay your pound plug of "terbacker" on the end of the beam and see whether it requires 100 or 200 pounds on the platform to balance it. Or, if you are west of the above mentioned stream, where everybody carries a "Colt 45" (except when they go to church), you can use it for a test weight, as everyone knows that the regulation Colt "peacemaker" weighs exactly two pounds.

New Wave Motor of the Float Type

By A. R. Maujer and Franklin Van Winkle

With this motor, by means of an ingeniously devised system of levers, power can be derived from every motion of the waves. Motor is governed by varying amount of submergence of floats, this being accomplished by compressed air which serves to force water out of a float to any extent desired.

The United States Wave Power Company is demonstrating on Young's "Million-dollar" pier, Atlantic City, N. J., the latest thing in wave motors. The ideas underlying this motor are most ingenious. By means of a system of levers and ratchet wheels advantage is taken of every motion of the water in sidewise and slantwise directions as well as in the vertical.

Fig. 1 is a general view of the upper part of the motor. Fig. 2 is a view under the pier, showing three of the floats which operate the machine. The motion and energy of the waves are imparted to the shaft *A*, Fig. 3, by means of mechanism which is the same for all floats; hence, a motor is divided into a given number of unit sections each composed of a float and the apparatus for converting the assorted motions of the waves into a rotary motion of the driving shaft.

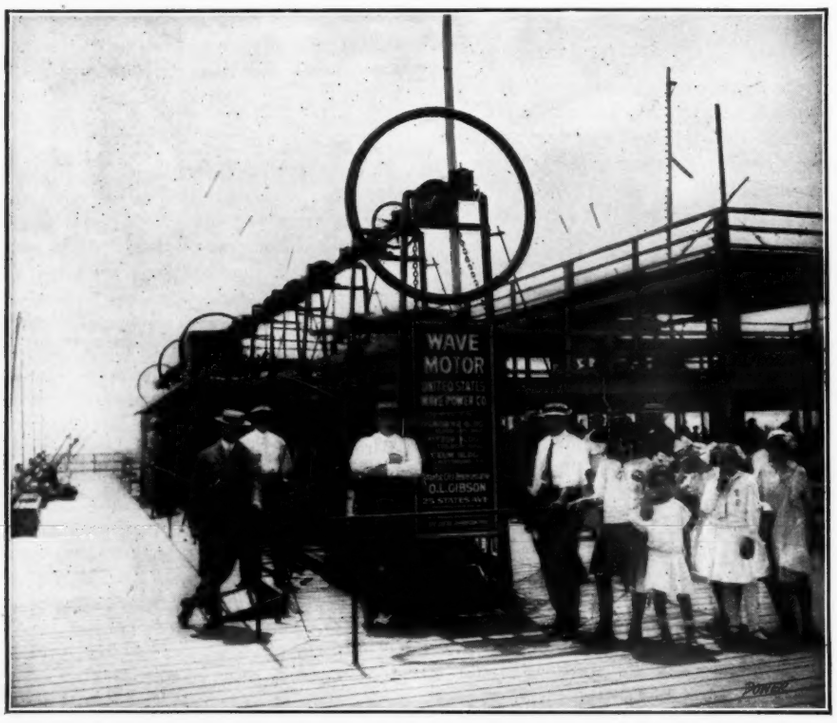


FIG. 1. VIEW OF THE ENTIRE SUPERSTRUCTURE OF THE WAVE MOTOR

The action of the machine may readily be understood by referring to Fig. 3. The float is free to slide up and down on the hollow rod *C* which has an open slot in one side. A lug at the top and one at the bottom of the float project through this slot into the core of the rod. To these lugs two chains are attached. The chain which is fastened to the upper lug passes up through the rod and over the ratchet wheel *D* and terminates with the weight *F*. When the float slides down on the rod, the chain causes the ratchet wheel to engage teeth on the shaft *B*, which is thereby caused to rotate with the wheel in a counterclockwise direction. When the float rises, the weight *F* makes the ratchet wheel rotate in the opposite direction; the ratchet then simply slides over the teeth.

The chain attached to the lower lug passes down through the shaft, over the pulley, then up again and over the ratchet wheel *E*, terminating with the weight *H*. When the float rises the chain causes the ratchet wheel *E* to turn the shaft counterclockwise, and when the float falls the wheel slides free. Thus, a vertical motion of the float either up or down tends to cause the rotation of the shaft *B*.

The upper end *I* of the rod *C* forms a ball and socket joint with the yoke *J*. The flanged disk piece *K* is integral with the ball *I* and the base ring *L* of the frame *M* rests on this disk. When a wave gives a sidewise motion to the float the disk *K* is thrown out of level and the frame *M* rides up on the high side of the disk. The lever *N*, which has its fulcrum at *O*, is fastened to the frame *M* at *P* by a compound hinge joint. As the end *P* of the lever is pushed upward the opposite end *Q* swings downward and the chain fastened thereto causes the ratchet wheel *R* to rotate the shaft *B*. Due to the large ratio between the lengths of the arms of the lever *N*, even a slight lateral movement of the float produces a considerable movement of the end *Q*. The counterweight *R* performs the same function as do weights *F* and *H*; namely, of keeping the chain taut on the ratchet wheel and causing the wheel to rotate in the reverse direction when the pull due to a wave is finished.

The power which the shaft *B* receives is transmitted through gear wheels of suitable ratio to the shaft *A*, which carries as many flywheels of proper size as are needed to steady the rotation; the number required depends, of course, on the size of the motor, that is to say, on the number of float units employed.

METHOD OF GOVERNING

The speed and the amount of power which the motor develops are regulated by means of compressed air. The floats, which are made of steel, are hollow and air tight except for four holes in the bottom, which are sealed by the water. Each float is connected by means of a flexible hose to a compressed-air tank which is located on the pier and in which a pressure of about 15 pounds is maintained. Thus, by admitting air the float can be entirely emptied or by releasing the air the float can be completely filled with water.

However little work there is upon the motor, it cannot run away, for, if the wheels upon which the pawls work were to run faster than the floats actuate the pawls they would receive no acceleration while such conditions existed. As there is always some resistance to the movement of the shaft its speed never gets beyond that at which a ratchet can exert a pull on its ratchet wheel fastened on the shaft. The energy taken up from the succeeding pulls of the ratchets is absorbed and distributed by flywheels on the main shaft which are of sufficient weight to do this efficiently.

SIZE AND CAPACITY

The size and capacity of a motor are determined by the number and size of the floats. The demonstration motor at Atlantic City is composed of six floats and the necessary transforming mechanism. The floats are 4 feet in diameter, 4 feet long and have a displacement of about 50 cubic feet. It is said by the officers of the company that the machine

is capable of developing between 100 and 125 horsepower, although no records of any authenticated test are available. A commercial plant would have not less than 32 floats.

Theoretical Estimate of Capacity

An estimate of the power derivable from the wave motions of a body of water by the employment of mechanism should be based upon a rational assumption of the forces and motions that are incident to water when agitated in the form of waves. When the crest of a wave is observed sweeping over the surface of an expanse of water, the eye naturally follows the moving crest and an impression is received that the same surface particles of the water remain on the crest of the wave, partaking of the same horizontal movement as the crest. As a matter of fact, visible wave motions consist, for the most part, of only a change of the form of the surface which rises up and down over the same place, much the same as a carpet on a floor would be disturbed by moving a rod sidewise over the floor under the carpet. The surface motions of waves

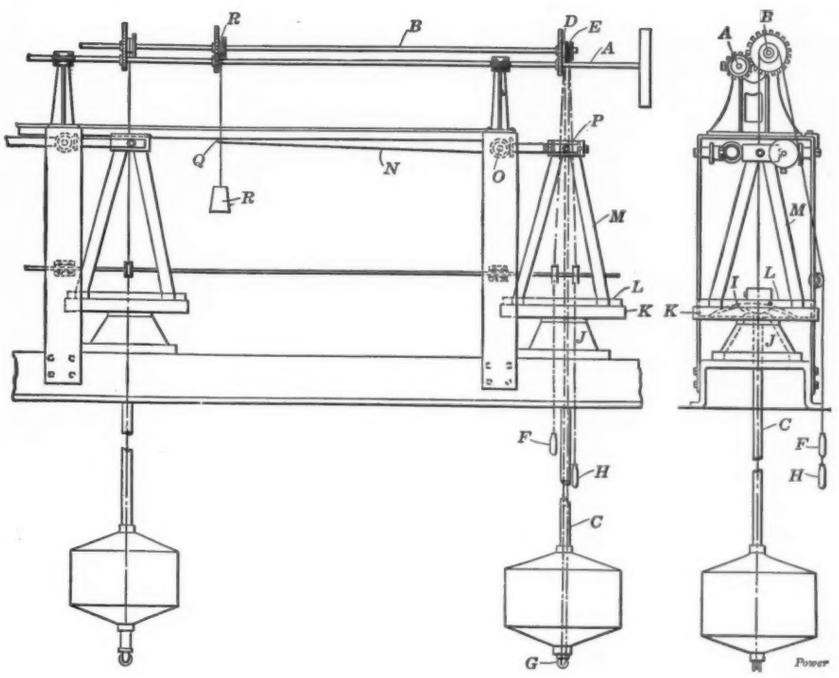


Fig. 3. Diagrammatic Arrangement of the Mechanism

Fig. 2. Three of the Floats Which Actuate the Motor

are clearly comprehended when the effect of wave motion imparted to a body of water covered with irregular-sized floating bodies is observed, as a field of broken ice. The floating masses appear, from the action of the waves, to have the motion of rising and falling very nearly over the same spot, combined with an oscillation forward as they rise, and an oscillation backward as they fall, being left slightly advanced in the direction of the motion of the wave's crest. This lateral motion is illustrated in the swaying of a spile loosely held to the bottom when swept over by the waves. The net horizontal displacement of the water may be very small from the passage of a single wave over the surface of a placid body of water; but when the surface is disturbed by a succession of waves, each accompanied by greater energy in the direction of the wave movement over the whole surface, the effect is to drag along the whole body of water with accumulating velocity in the direction of the main surface-wave motion.

The wave motor herein described is intended to gather energy both from the horizontal and from the vertical motion of the particles of the water in which it may be immersed.

Wind, weather and other conditions which affect the hight, speed and frequency of ocean waves are all so variable that any assumption of average combination of vertical and horizontal motions available for a stated location must be regarded as purely conjectural.

Computations based on data conceded by the promoters, and in which the motor is given the benefit of every doubt, result in convincing one that the power

which the motor is capable of developing is decidedly less than 100 horsepower.

Each of the six floats, 4 feet in diameter and 4 feet high, has a displacement of about 50 cubic feet, and as a cubic foot of water weighs approximately 62.5 pounds, each float, therefore, weighs

$$50 \times 62.5 = 3125 \textit{ pounds}$$

less when in the water than when out. No matter what may be the form or material of a body, when it is submerged it is at all times buoyed up by a force equal to the weight of the water which it displaces. Assuming that a float of the wave motor is at the lowest point of its vertical travel, that it displaces 50 cubic feet of water and that the float itself has a total weight, out of water, of 3125 pounds, then the rise of a wave would lift the float, but the buoyancy of the water would lift nothing additional to the weight of the float. Under that condition, no work could be gotten out of the upward motion of the float. On the downward motion, work could be obtained to the full effect of the weight of the water which had been displaced during the upward motion, and through the distance raised, provided the mechanism for absorbing the work of the downward motion is of such a character that the wave in dropping falls so much more rapidly than the float as to exert no buoyancy to retard the gravity of the float. If the float is lightened or counterpoised in any manner exerting a lifting action during its upward travel, tending to decrease the weight of the float in the water, then an effect equal to such a lifting effect will act against the downward motion of the float. It is immaterial what proportion of ballast is carried or how the parts are counterpoised, the total effect for a rise and fall of a wave can be only the displacement (3125 pounds) raised the hight of the wave, minus the half hight of the float. Assuming the effective rise to be 2 feet and the frequency of the waves once in 5½ seconds, the total power exerted by the waves in raising six floats would be,

$$3125 \times 2 \times \frac{60}{5\frac{1}{2}} \times 6 = 409{,}090 \textit{ foot pounds per minute} = 12.4 \textit{ horsepower.}$$

Conceding that the average lineal sweep of each float is six feet forward and six feet backward, occurring once every wave interval of 5½ seconds, then the total lateral motion per minute made by each float may be assumed to be

$$6 \times \frac{60}{5\frac{1}{2}} \times 2 = 130.9 \textit{ feet per minute}$$

According to the experiments of Poncelet, the highest efficiency in the conversion of the energy of the water is attained by a float in an unconfined channel, when the velocity of the float is one-half the velocity of the current. Therefore, to estimate on a basis of current velocity which would yield the highest efficiency for a float velocity of 130.9 feet per minute, calculation would have to be made on assumption of a current velocity of

$$130.9 \times 2 = 261.8 \textit{ feet per minute,}$$

assumed as an average velocity of water creating lateral pressure on the float. Each float being 4 feet in diameter and 4 feet high, a projected area of 16 square feet would be the greatest cross-sectional area of current acting on a float.

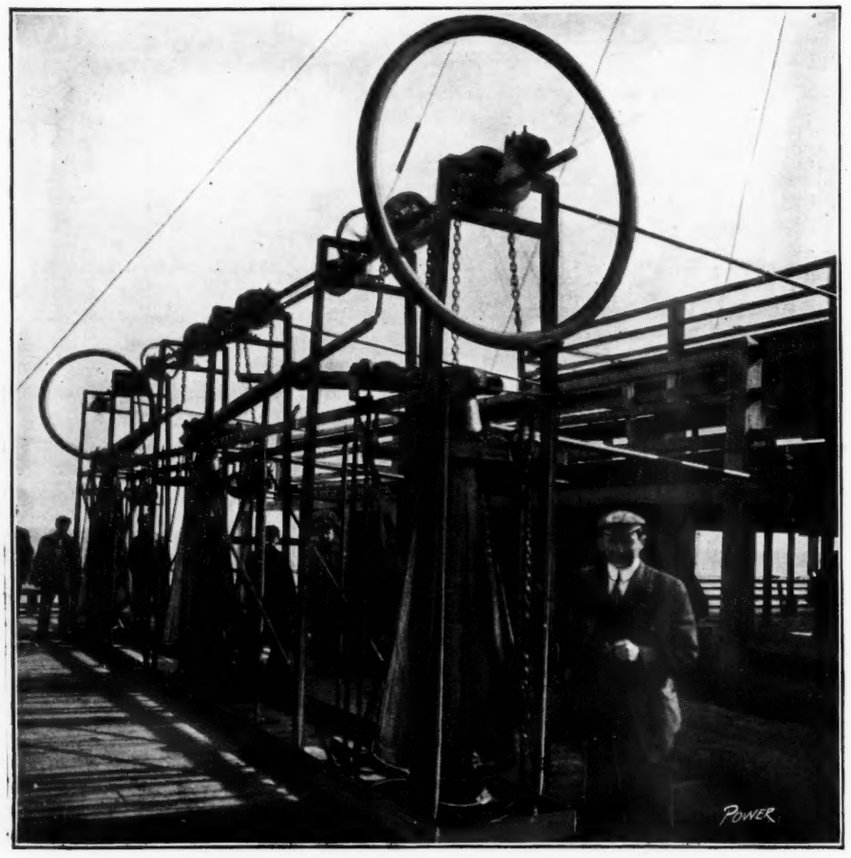


FIG. 4. VIEW OF ONE SECTION OF THE SUPERSTRUCTURE

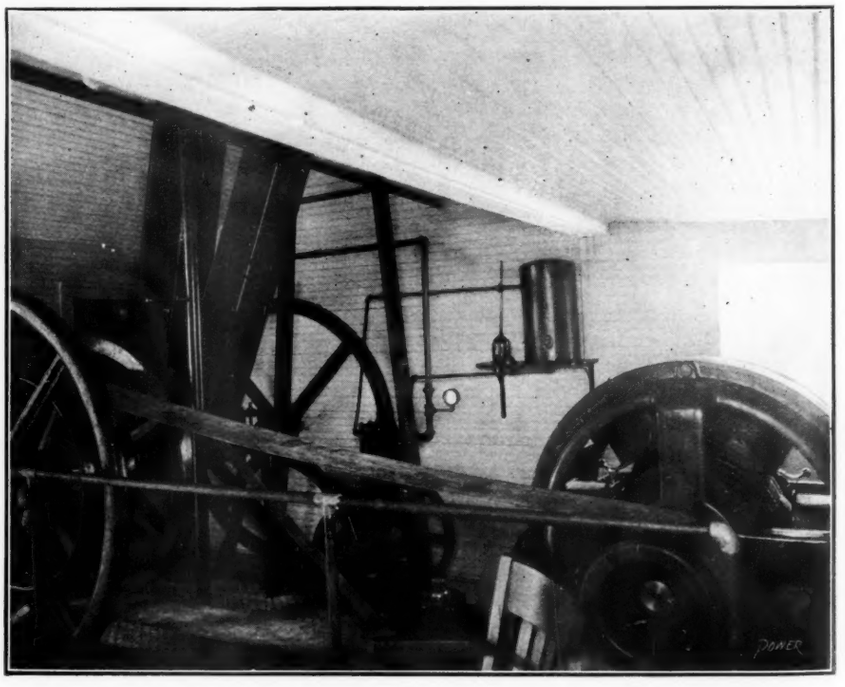


FIG. 5. THE COUNTERSHAFT, GENERATOR AND AIR COMPRESSOR DRIVEN BY THE WAVE MOTOR

The assumed current velocity of 261.8 feet per minute is equivalent to a velocity of 4.36 feet per second. Each float would, consequently, have presented to it during a second of time

$16 \times 4.36 = 69.76$ *cubic feet of water,* equal to,

$$69.76 \times 62\tfrac{1}{2} = 4360 \text{ pounds}$$

of water per second, at a velocity of 4.36 feet per second. Finding the kinetic energy of the water, in foot-pounds per second, by the usual formula,

$$K = \tfrac{1}{2} M v^2,$$

by substituting

$$M = \frac{4360}{g}$$

$v = 4.36$ feet per second and $g = 32.2$, we find:

$$K = \tfrac{1}{2} \times \frac{4360}{32.2} \times (4.36 \times 4.36) = 1287$$

foot-pounds per second

and presented to six floats would make,

$1287 \times 6 = 7722$ *foot-pounds per second.*

Poncelet determined that the highest percentage of energy obtainable from an unconfined current acting on flat float boards normal to the direction of the current was 40 per cent. of the kinetic energy of the obstructed current. In the case before us the surfaces acted upon by the current are convex-circular cylinders, a form well established as offering only one-half as much resistance to the motion of an unconfined fluid current as flat surfaces normal to the direction of the flow. Absorption of current energy by the cylindrical form of float could therefore not be in excess of 20 per cent. of the kinetic energy of the current. The maximum lateral or current energy absorbed by the six floats would therefore be but 20 per cent. of 7722 foot-pounds per second, or only 1544.4 foot-pounds per second, equal to 92,664 foot-pounds per minute, from which it becomes evident that the total power which the waves can impart to the six floats in lateral motion is

$$\frac{92{,}664}{33{,}000} = 2.8 \text{ horsepower}$$

This, added to 12.4 horsepower, receivable from the up and down motions, gives 15.2 horsepower as the maximum power which the waves could impart by all motions to the six floats of the motor during continuance of the conditions which are conceded.

But, beyond this, the efficiency of the mechanism for the conversion of the energy applied to the floats into energy developed in the form of the rotation of the shaft and the losses of power consumed by the speed-governing mechanism have to be taken into account. From the character of the mechanism employed for these purposes it would appear that not more than 75 per cent. of the initial energy applied to the creation of the motions of the floats would be recoverable in useful work in the form of rotary power deliverable from the shaft of the motor. Thus, allowing 75 per cent. efficiency of the mechanism, the estimated actual or brake horsepower of the motor, operating under the conditions which are conceded, appears to net but 11.4 horsepower.

Commercial Value

The cost of operating a power plant is not made up of fuel and labor alone. The standing charges, made up of interest and depreciation, insurance, taxes, etc., form a considerable proportion. It is quite possible to put so much money into the development of a water power that the standing charges would pay those of a steam plant and the fuel and operating costs as well. This is the crux of the wave-motor situation. Can such a device be built for a cost that will permit its use in competition with established sources of power?

There is no authenticated test of the power which the motor under review will produce. On the day that the writer saw it, it was operating a small air compressor and furnishing air enough to blow a whistle occasionally. The generator could not be run because the belt was broken and something was the matter with the pump.

As has previously been mentioned, the promoters claim that they have gotten 100 to 125 horsepower out of the motor, and that its cost, including changes, revisions, substitutions of parts, etc., is in the neighborhood of $50 per horsepower. They also claim that they have estimates that show that a commercial plant can be built for $17.50 per horsepower, allowing $3 per horsepower for pier or crib work. The crib would be built of concrete and steel and the power transmitted to land by cable.

The plans of the company are to build a commercial plant at Boston or New York as soon as enough stock is sold to render this possible.

Intending purchasers of stock should satisfy themselves as to the correctness of the estimates of capacity and cost.

Flue Welding in Repairing Boilers

By H. S. Jeffery

If the condition of a boiler is such as to necessitate the removal of tubes in order to get at the inside of the shell, and the tubes are not pitted or otherwise rendered unfit for service, they may be used again by welding a small section on to the end which was cut during the process of removal.

It seems to be one of the first principles with many owners of boilers that the tubes shall not be removed until all efforts to keep them from leaking have been exhausted. However, when the efficiency of the boiler has been decreased to a marked extent due to the deposit of foreign matter, then it is often necessary to remove the tubes, whether they leak or not, and clean the boiler shell. The money expended for removing and replacing the tubes will be well spent, there being no necessity for throwing away the tubes which are removed from the boiler and replacing with new ones, unless they are badly pitted.

It is now the practice to again use the tubes which have been removed from a boiler. This is accomplished by welding on the end of the tube a section about six inches long, called a "safe-end." Frequently the safe-end is somewhat heavier than the tube, and the general rule is to install it so that this end of the tube is expanded to the flue sheet of the firebox or furnace; this is because the new end of the tube is firmer and stronger than the old tube, and consequently can be expanded into the firebox tube sheet better than the old tube. Also, as a rule, the new section when expanded into the hole maintains a better joint than the older and thinner tube.

The chief difficulty with flue welding is the desire to weld a great many flues in a given time, and too often the quality of the work is sacrificed for quantity; the whole saving, however, is lost on account of the expense and time required to remove, reweld and replace those which are found to have defective welds when the boiler is tested. Although the flues may be tested both before and after being installed in the boiler, a defective weld may not show until the boiler has been in service a short time.

The manner of welding the safe-end to the tube is very important, the practice in some shops being to scarf both the tube and the safe-end about ½ inch as shown in Fig. 1. This practice is open to the objections that the thin edge

of the tube is liable to burn off, and unless the operator is experienced some parts of the flue when welded are liable to be welded thinner than the balance of the flue. Another method is to scarf the safe-end, opening up the flue to overlap the safe-end as shown in Fig. 2; while others reverse this process, scarfing and opening up the tube to overlap the safe-end. Many, however, have abandoned the practice of scarfing either the flue or the safe-end, depending upon the disk or cutter, used for cutting the flue and safe-end, to bevel the edges for the purpose of welding. Flues welded in this way are called "short lap-welded," the short bevel or scarf making a solid weld as it affords sufficient metal through the weld to be worked down to size. When welding the safe-end to the tube, the latter should be upset against a cross-bar at the back end of the welding furnace. It is also important to see that the welded portion is not oversize or undersize; a flue which is oversize at the weld will be hard to insert into the boiler, and if undersize the chances are that the walls at the weld are thinner than the balance of the flue. It is the practice in many shops to weld and swedge the flue in the same heat, but this requires that the whole safe-end be heated unless it is exceptionally long. This practice has in many instances injured the weld, the swedging operation being attempted when the safe-end was too cold. In other shops

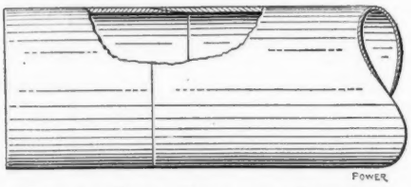


FIG. 1. BOTH TUBE AND SAFE-END SCARFED

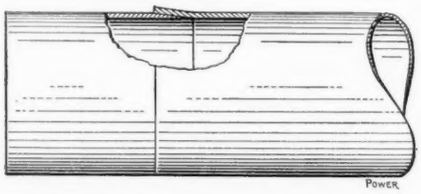


FIG. 2. ONLY SAFE-END SCARFED

the flues are welded, allowed to become cold and the weld tested, after which the ends of the flues are heated, swedged and annealed.

In some shops the welds of the flues are tested under pressure in a machine made especially for that purpose, although in the majority of cases a wooden plug is driven into one end of the tube; the tube is then filled with water under pressure, and the weld is hammered lightly with the peen of a chipping hammer. Still others test the welds after the flues have been installed in the boiler but this is poor practice. The flues when swedged should be turned several times, making the ends round and the swedged portion central with the balance of the flue. After the foregoing operations the flue ends while heated to a cherry red should be placed in a bath of lime, thus annealing the flue so that it can be expanded to the flue holes and beaded to the sheet without danger of splitting the flue.

Although a boiler may be opened and washed out periodically all the scale and mud will not be removed, and though the flues may not leak, it may be necessary to remove them so as to thoroughly clean the boiler. In such cases it is not usual to remove all the tubes, the practice with many being to remove the lower tubes as indicated in Fig. 3, which is called a V. This practice is more general with the locomotive type of boilers than with tubular boilers. The majority of the latter type of boilers are now being constructed with a manhole under the flues, which permits the scale and mud to be

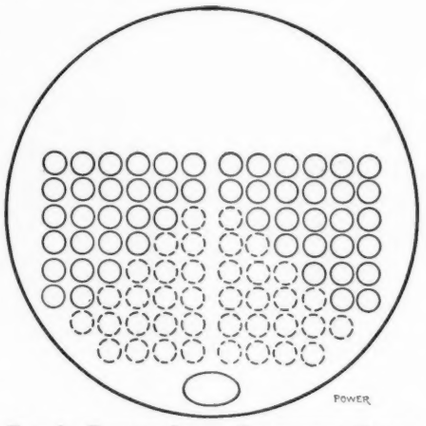


FIG. 3. DOTTED LINES REPRESENT TUBES REMOVED

removed from both the boiler shell and the flues without removing the flues.

It is important that the tubes be as straight as practicable. Those removed from the lower rows are liable to be bow-bent, especially if they are long and considerable scale has adhered to them. If installed in the boiler when bow-bent, some of the tubes may touch, or nearly touch, one another, creating unequal water spaces between the tubes and preventing proper circulation, also affording spots where sediment will lodge. The tubes which are cleaned in a revolving machine, called a "rattler," should be cleaned by rubbing against one another, the rattler revolving at a very slow rate of speed. Small pieces of iron and steel may be used in the rattler to aid in cleaning the tubes, but large pieces should not be used as they will cause dents in the tubes.

Frequently one or more flues will leak to the extent of practically putting out the fires. The leak may be the result of the joint between the flue and the hole becoming broken, or a hole being eaten in the flue or the weld in the tube parting. It is not always possible to cut the boiler out of service, in which case the flue is plugged by driving a cast-iron tapering plug into the flue.

Sometimes the joint between the flue and the hole will become broken and the bead of the tube partly broken off; in such cases, but only in an emergency, the flue may be repaired by cutting the bead off flush with the flue sheet and placing a section of tube inside of the tube as shown in Fig. 4. The old flue is first

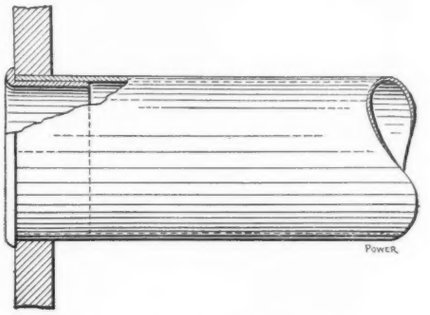


FIG. 4. TUBE HELD IN PLACE BY SMALL SECTION AT END

expanded hard against the sheet, after which the section is inserted within the old tube, expanded hard against it and beaded to the tube sheet in the same manner as the original tube. The section being only indirectly cooled by the water within the boiler is liable to become overheated, and especially if fine particles of coal, etc., are allowed to lodge around and within it. The only object in using the section in preference to plugging the flue is that the latter practically cuts out the flue and reduces the heating surface, while the former permits the flames and hot gases to pass through the tube as before, thus maintaining the heating surface.

The International Electrical Company, Limited, with offices in Nelson, B. C., and Portland, Ore., has filed plans for the development of a large electric power plant from the falls on the Pend d'Oreille river. The river runs from Canada to the United States, some 50 miles southwest of Creston, B. C., and for nine miles before reaching the boundary it is a series of rapids. At a point some six miles above, on the Canadian side, a site admirably adapted for the necessary development works has been staked, and it is expected that a city will be located in the vicinity, to be known as Falls City. W. E. Moore, hydraulic engineer, of Spokane, has made an investigation and report on the power sites of the river, in which it is stated that the upper site is capable of a total development of 65,000 horsepower and that the cost will be about $60 per horsepower. The Sheep creek and Ymir mining districts are only fifteen miles away, and the power sites are within 100 miles of Spokane.—*Electrical World.*

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Some Notes on the Operation of the Lackawanna Steel Works Engines*

By E. P. Coleman

The Körting engines used at the Lackawanna Steel Company's plant at Buffalo did not show satisfactory operation during the first three years of their existence, but the author believes that essentially all of the trouble can be traced to several major causes tending to produce premature combustion, and a number of minor details not well appreciated at that time.

The conditions tending to produce premature combustion and attendant failure of parts subject to the resulting high pressures and temperatures were imperfect piston rings, neither properly doweled nor provided with keepers; unsuitable oil used in the motor cylinders; and high hydrogen content in the gas. Minor causes of premature combustion were projecting portions of parts exposed to the fire, and accumulations of flue dirt which, in combination with the oil, baked on the surfaces of the parts; the projecting portions remaining incandescent and initiating premature combustion. Minor troubles were also due to various causes, such as wet gas which fouled the igniter points with its accompanying flue dirt; dirty gas which clogged the valves of the controlling devices, making the speed control more difficult; imperfect rod packing, which produced bad atmospheric conditions in the building; inadequacy of certain parts of the 1000-horsepower engines subject to high inertia stresses at 100 revolutions per minute.

Rectangular dowels are now applied to the piston grooves in such secure manner that the openings through the snap rings are confined to a location near the bottom of the cylinder, thus preventing leakage through the openings. The cylinder oil now used does not leave a carbonaceous residue of any considerable magnitude. The pressure of water supply to tuyeres, coolers and bosh plates is maintained slightly lower than the internal pressure of the furnace; hence cool water cannot enter the furnace to produce excessive hydrogen, following puncture of these parts.

As originally installed, the cylinders, pistons and muffling sprays were all supplied with water through individual connections, each wasting to a sewer. The system has since been modified so that the water passes through piston, cylinder heads, cylinder jackets and muffling sprays in the order named. A small portion of the water only is used by the muffling sprays.

Thermometers are set to indicate the temperatures of the water leaving the piston and cylinder jackets. The jacket water leaving each cylinder head discharges upward through a vertical pipe provided with a return-bend discharge nozzle. The water leaving the nozzle discharges downward into a funnel leading to the cylinder jacket, the stream thus being in full view of the operator.

Cylinders, Pistons, Rods, Etc.

The average life of a motor cylinder is about four or five years, during which time the wear as measured on a diameter is about ⅜ of an inch. The cylinder is then bored out and bushed. There are practically no cylinder failures from any cause other than wear.

Exhaust ports at power house No. 1* become clogged with flue dirt and require cleaning after about three months of operation. Exhaust ports at the blowing-engine houses do not foul at all. The difference is probably due to the cleaner gas at the blowing-engine houses, and possibly in some degree to the precipitation of moisture and dirt in the 96-inch headers.

Cylinder relief valves require cleaning about once a month. Jackets of cylinders and heads are cleaned about once a year.

Cylinders and pistons are inspected only when conditions indicate. Their wear is measured and recorded at the same time. A test for tightness consists in placing the crank on the dead point and subjecting one end of the cylinder to air or exhaust pressure, the plugs being removed from the opposite head to indicate leakage, if any, through the piston.

The blowing-engine pistons have a life of from three to five years. There are but few piston failures due to any cause other than wear. A few have occurred which have been due to the water connections falling down inside the piston and wearing a hole through the bottom. When a piston has worn, say $\frac{5}{16}$ inch at the bottom, it is turned over and used in a standard cylinder. There are at present two standard diameters, 38½ inches for new cylinders and 37½ inches for bushed cylinders.

In dismantling a piston the large piston nuts are heated, removed, cleaned up in the lathe and used again. About half of the small piston nuts have to be split off, the rest being utilized again. There is considerable corrosion around the studs and nuts and at the joint between rod and piston, forming what may be called a rust joint. The tail rods are removed from the piston either by means

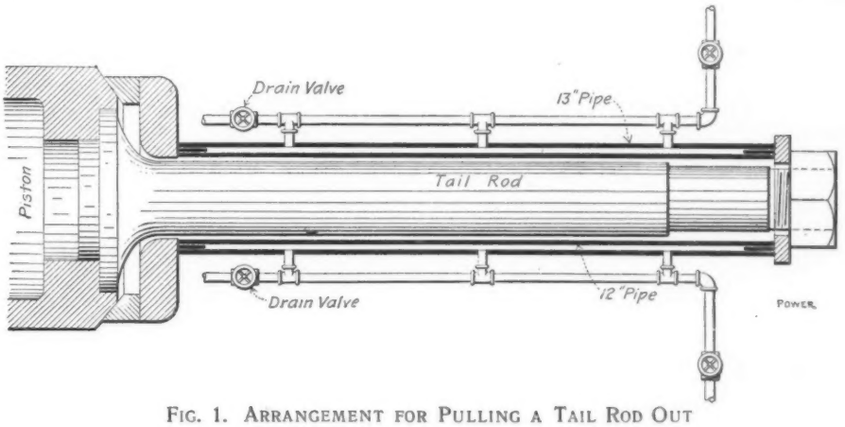


Fig. 1. Arrangement for Pulling a Tail Rod Out

*From a paper presented at the annual meeting of the American Society of Mechanical Engineers, December, 1910.

*See description of plant layout in the partial abstract relating to the gas-cleansing system, page 30, January 3 issue—Editor.

of the special device shown in Fig. 1 or by means of screw jacks and rams. When using the former, the concentric pipes are first cooled with water and the nut at the end of the tail rod is set up; steam is then admitted between the pipes at atmospheric pressure to lengthen the pipes by heating them. This cycle is repeated until the rod is free from the piston. When it becomes necessary to remove the piston rod, the piston is broken away either with dynamite or under the drop hammer. The wear of piston rods occurs principally at the end of the stroke and amounts to about a quarter of an inch on the diameter in three years. It is then turned and will suffice for two or three years more.

The average life of the motor cylinder heads is not well established, but it may be set at three years or more. A few of the original heads at the blowing engines are still in service. Failures of these occur principally at the junction of the jacket wall and the main flange on each side of the inlet valve chamber, but this trouble has been substantially eliminated by employing proper fillets. Some heads have developed cracks through the inner wall; two or three have had the inner walls blown entirely away, but this was found due to faulty castings.

Gas-pump cylinders and heads require cleaning every six to eight months on account of dirt getting into the clearance near the bottom. By feeding a little kerosene through the pump valves cleaning is avoided.

Cylinder heads are packed principally with $\frac{1}{16}$-inch woven-wire insertion asbestos sheet. Piston joints are made up either with $\frac{1}{32}$-inch wetted asbestos paper, or with a paste of litharge and glycerin, or with another form of packing known under the trade name of "900." All give satisfactory results. The life of the $1\frac{7}{16}$-inch snap piston rings is about two years.

The piston rods are packed with four cast-iron rings of the Walker type in a casing exterior to the head. Packings are overhauled about every six months to renew broken springs and rings. Castings are trued up at the time of overhauling the piston once in two or three years.

The swinging connections for the piston water supply require to be packed about twice a year.

Valves, Cams, Shafts, Etc.

The inlet valves last about three years before turning and about the same time after they are turned down. They do not require grinding-in except when new. Stems are broken occasionally near the top yoke. Little cleaning of the inlet valve or the ports is necessary.

The inlet valves are operated through heavy push rods driven by cams and rollers. High inertia stresses are thus developed at the higher engine speeds. With present inlet-valve springs, which operate under a compression of 2500 to 3500 pounds at the blowing engines, the roller leaves contact with the cam at about 65 to 70 revolutions per minute. Many of the original push rods have been broken by the resulting inertia stresses and new and stronger rods have been made.

The life of the inlet cams is about six years. Wear of the steel gears of the layshaft occurs on four teeth at the end of four or five years; the gears are then shifted on the shaft so that unworn teeth are in action during the inlet-valve opening.

The shaft of the 2000-horsepower engine, which is of the built-up type, has caused no trouble whatever. There have been, however, several shaft breakages at the 1000-horsepower engines, which have shafts forged in one piece and operate at 100 revolutions per minute. The author has made no investigation relative to the stresses in these shafts, but believes that their life would have been longer had they been of the built-up type and of present diameters.

At the 1000-horsepower engines there has also been trouble with certain brackets and fastenings due to inertia stresses set up by the inlet gear. The governor being driven from the layshaft, considerable wear is imposed on the mechanism due to reversal of the torque at the layshaft as the point of each cam passes under the roller. Some trouble from premature ignitions by the 1000-horsepower engines was experienced, due to the indicator holes through the flanges of the cylinder heads, and water-cooled indicator connections were substituted.

Ignition

Ignition is effected by means of make-and-break igniters, of which there are two in each cylinder head. Until recently the ignition current was furnished by magnetos, one for each plug. The current is generated by this form of magneto in the following manner: The armature is first slowly rotated in opposition to the force of a spring through an angle of about 30 degrees from its initial position; it is then released and under the action of the spring executes a rapid return motion or oscillation. During this return motion the igniter terminals are mechanically separated and an arc formed, the motion of the armature being transmitted to the plugs through cranks and reach rods for this purpose. The magnetos are now being discarded in favor of a direct-current system of ignition of simple form.

The detailed construction of the igniter plugs is indicated in Fig. 2. The bronze bushing forming the spherical seat for the movable steel electrode is a driving fit in the cast-iron body of the plug. The cylindrical head of the stationary electrode seats on an asbestos gasket or washer carried by the porcelain insulating plug, which is formed as a conical frustum seated in a cavity in the cast-iron plug on a bedding of litharge and glycerin. Litharge also assists in maintaining tightness between the cast-iron plug and the bronze bushing. This construction is very satisfactory in every way.

Using magneto or similar low-voltage current, there is little burning of the points, and the life of both electrodes is about one year. The bronze bushing lasts about six months, this material being the most satisfactory thus far used. The upkeep of the magnetos is relatively expensive, and a ten-volt direct-current system is being substituted.

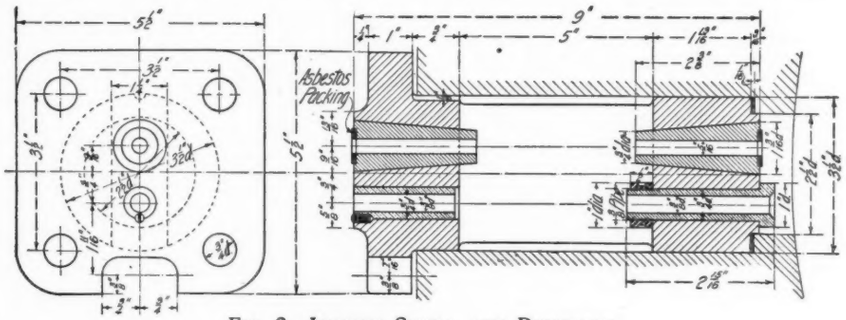


Fig. 2. Igniter Shell and Bushings

Dirty plugs are caused by slipping furnaces and wet gas containing dirt which fouls and bakes at the terminals. The plugs require cleaning on an average of once or twice per month. The spherical seat requires regrinding once in two months, and the plug must be retubed once in six months.

With the type of ignition gear described there is an interval between the release of the magneto lever and the opening of the igniter terminals. There is also an appreciable time required to complete combustion. This time element being approximately constant, correct ignition requires that the timing of the release shall vary to some extent with the speed of rotation. The ignition gear may then be linked to the speed-adjusting device in such manner as automatically to maintain proper timing of the ignition at all speeds.

An Operator's View of the Diesel Engine

By G. H. Kimball

In an article in the May 31 issue, some very favorable statements were made in regard to the Diesel engine; these and others made in the catalogs convey the impression that the engine has no disadvantages whatever. If this were true, there is no reason why everybody should not install them.

It may be of interest to engineers and possibly to some owners of plants, to hear of some experiences in plants where these engines are in operation. As with all internal-combustion engines, there are many drawbacks which do not appear in a good steam plant, and where a steam engine will run under adverse conditions a Diesel will not operate at all.

Those of the three-cylinder and six-cylinder type, with 16x24-inch cylinders, seem to be the most successful. In one plant a six-cylinder unit was installed which gave excellent service for the first year, with no repairs other than a new governor gear. It was necessary, however, to spend about ten hours every week in inspecting and taking up connections and various other parts. One thing that made this type of engine successful in that plant was that there were both steam and water power besides, so that it was not necessary to hire any more help, as the firemen could be used when the steam was not required, and when there was plenty of water power available ample opportunity was given to thoroughly overhaul the oil engine and get it ready to give good service when needed. Moreover, when steam was depended on alone for auxiliary power it was necessary to keep a boiler in service for two or three months, in case of emergency, and this standby loss was saved by the Diesel engine. In this class of plant the Diesel engine can be used to marked advantage and with great economy.

In a plant where the whole load must be carried by the Diesel engine, however, we have a far different proposition. In one such plant where there were two units, one new and the other about three years old, it was necessary to spend all of Saturday afternoon, when part of the factory was shut down, and nearly all of Sunday in adjusting wristpin and crankpin boxes, inspecting parts and the condition of the crank-case oil. This was regular routine work, and in case of regrinding valves, renewing the oil or anything extra, just so much more time was required. The fuel valves gave trouble by breaking at the points and there was a great deal of wear due to the jar and shock of the six reciprocating systems working at such high pressures.

The governors gave a great deal of trouble in the way of unsteady running, so that it was necessary to replace them on both the old and the new units.

The first cylinder on the older engine after being overhauled gave great trouble by pounding at every second stroke, even when the clearance, as measured by compressing a lead wire, showed one-eighth of an inch, as required. Finally it was found that the piston head bulged upward by the heat to such an extent that when all the parts were hot it touched the cylinder head.

The cam-shaft gears of this unit were also badly worn, making new gears necessary. One cylinder of this and one of the newer engine were found to be worn from 0.045 to 0.095 of an inch large in places. The rings after a year's run became so badly carbonized as to require new ones to be substituted, and the wear of the wristpin boxes made either new boxes or shims on the wedges necessary in a short time.

Many of the published performances of Diesel engines have been those where the load factor is 25 to 35 per cent. The engines will run very steadily with such a load, because the heating and wear of the parts are not comparable to the heating and wear that occur with a load factor of 75 to 90 per cent. The load factor was the difficulty in the last mentioned plant; the management wished to carry full load all the time, and sometimes an overload, and it was disappointing to find that the cylinders must be made tight before such a heavy load could be carried. To this end the pistons were fitted with two more rings, which made a great improvement, but in a short time it will be necessary to rebore the cylinders.

In the article to which I have referred it was stated that after a four years' run the tool marks were not worn out of the cylinders. To anyone who has seen hard service by these engines this statement will seem rather far-fetched; in the plant which I mentioned last not only were there no traces of tool marks but there were deep grooves worn lengthwise of the cylinders, although there was plenty of cylinder oil in evidence.

When it is necessary to remove a cylinder head, about all the valve-gear and other parts related to the cylinder must come with it, which will consume no small amount of time, and everything must be replaced with the greatest care or the results will be very unsatisfactory.

The clearance must be maintained just right or the proper compression temperature to ignite the oil will not be attained.

Although the regulation is said to be equal to that of steam engines, it cannot equal that of a modern automatic cutoff or Corliss engine; regulation within 2 per cent. has not been shown in actual practice, 4 per cent. being considered good.

The crank-case oil is also a source of trouble, and it is not surprising to find that the oil has disappeared after a hard week's run. Sometimes it is so thick that the bearings must be very warm before it will flow at all.

The air compressor is a very important part of the plant, and it must be capable of hard, continuous service, for any drop in pressure during a heavy load means a shutdown. Careless selection of a compressor will entail a great deal of trouble, for there are some designs that are very unreliable.

The fuel economy is very high and in plants where steam is not needed for other purposes than power there is a great saving in fuel. In the matter of labor, there is very little difference from a steam plant; it is customary to pay higher wages to Diesel engineers than to engineers in steam plants of like power, and while it is a simple matter to operate the engine, repairing requires plenty of help.

The first cost is excessive and unless a plant has a spare unit it cannot give the service that a steam plant would, and it is a question whether the engine would not have to be replaced after ten years of service.

In writing the foregoing, it is not my intention to make any unfair statement; my experiences with the Diesel engine have been exactly as described in this article, and I have said nothing based on rumor or hearsay. Furthermore, I am convinced that this type of engine should, after some further experience and improvement, prove very sucessful and capable of continuous service at full loads.

[We do not question Mr. Kimball's sincerity, veracity or operating skill in the slightest degree, but we confess inability to understand why the cylinders of a Diesel or any other engine should be scored longitudinally when cylinder oil is plentifully applied, if the oil is of the proper kind and the air intake is carefully protected from dust and grit. We have known cases of extremely bad cylinder scoring caused by both unsuitable oil and unprotected air intakes.—Editor.]

The Navy Department is planning to experiment with electric lifting magnets for recovering torpedoes which are fired in practice and, through some fault of the controlling mechanism, go to the bottom after their energy is expended. These torpedoes are virtually small submarine vessels with self-contained power plant, steering mechanism, etc., and each one is worth a small private fortune. The points where they are lost will be marked by buoys and magnets then dropped down to grapple them and bring them to the surface. Owing to the buoyancy of the water magnets of relatively small lifting power may be used, but the magnets must be constructed to withstand the submersion and the temperature changes.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Catechism of Electricity

SINGLE-PHASE COMMUTATOR MOTORS

1124. *Are commutators ever used on alternating-current motors?*

Yes; commutators are used on some single-phase motors. Fig. 363 illustrates one kind of commutator motor.

1125. *For what kind of work is this motor particularly intended?*

For driving machines which must run at variable speeds and those requiring considerable starting torque.

1126. *Explain the construction of the motor referred to.*

Fig. 364 shows the principal parts of the motor, and Fig. 365 is a diagram of its connections and windings. The field-magnet core *A* is fitted with a single-phase winding *N* of concentric coils, each coil being separately taped and insulated. For operation on 220-volt circuits these four nests of field coils are connected in series; for 110-volt circuits they are connected in parallel.

The armature is provided with a winding of the "two-circuit" drum type, connected to an ordinary commutator upon which press two sets of brushes *E* and *C*, Fig. 365. The pair *E*, called the "energy" brushes, is permanently short-circuited and displaced at an angle to the lines of field or primary magnetization. The second set *C*, called the "compensating" brushes, is connected to a relatively small field winding which serves to induce in the armature an electromotive force which tends both to raise the power factor and to maintain approximately constant speed at all loads. By the use of a controller arranged to insert resistance or reactance in series with the energy and compensating circuits of the rotor, the speed can be reduced to any desired rate between full normal speed and half that speed. For example, if the normal speed is 600 revolutions per minute, any speed between that and 300 revolutions per minute can be obtained with the controller.

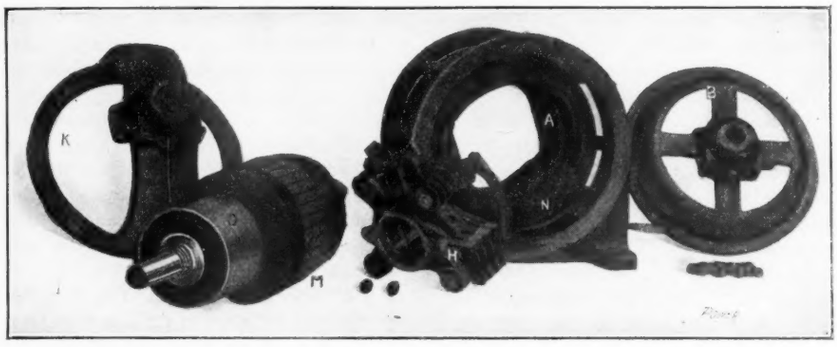


FIG. 364. DISASSEMBLED VIEW OF THE MOTOR SHOWN IN FIG. 363.

1127. *Will the speed be constant when reduced by the insertion of resistance?*

No. The motor behaves like a shunt-wound direct-current motor with resistance inserted in the armature circuit; when the load increases the speed decreases considerably, and *vice versa*.

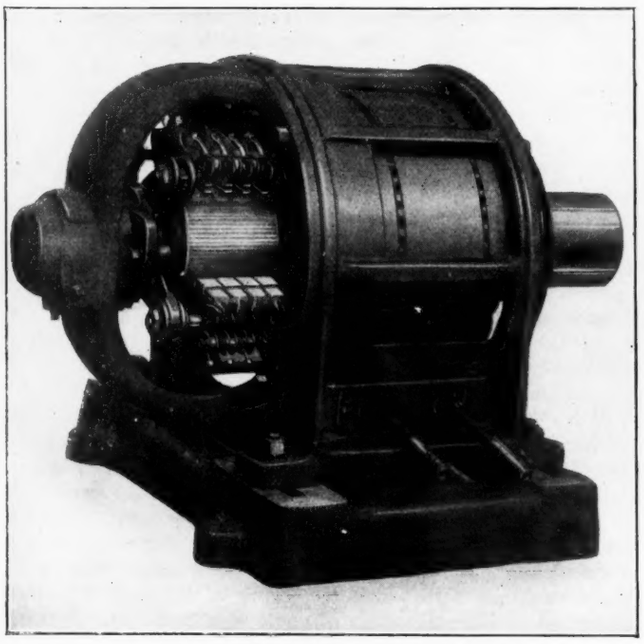


FIG. 363. GENERAL ELECTRIC SINGLE-PHASE COMPENSATED REPULSION MOTOR

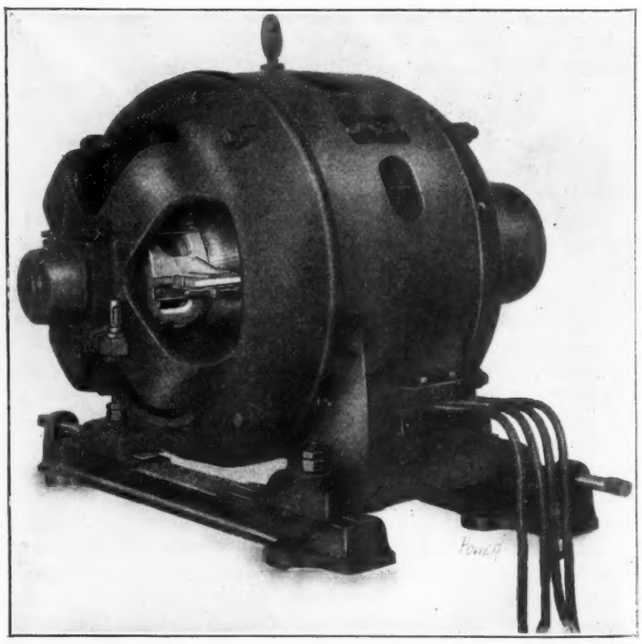


FIG. 366. WAGNER CONSTANT-SPEED SINGLE-PHASE MOTOR

1128. *What kind of motor is the one just described?*

It is a compensated repulsion motor; this name is given to it because the motion of the rotor is due to magnetic repulsion between the current in the short-circuited part of the winding and the stator field, and the undesirable reactions

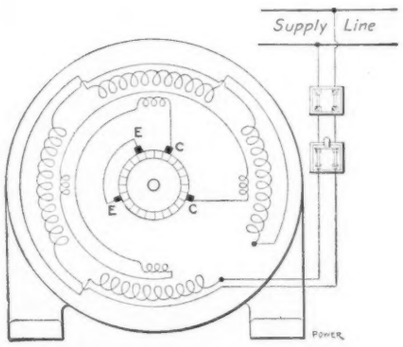


FIG. 365. CIRCUITS OF A COMPENSATED REPULSION MOTOR

in the rotor winding are neutralized or compensated by the auxiliary field set up by the small stator winding connected to the compensating brushes.

1129. *Are there any other forms of single-phase commutator motor?*

Yes. There is a type of machine which acts as a repulsion motor while starting and is automatically changed to a simple induction motor when it reaches normal speed.

1130. *Illustrate and describe a motor of this type.*

Fig. 366 is a view of a 20-horsepower Wagner motor of this type, and Fig. 367 shows the commutator end of the Wagner armature. A disk-shaped commutator is used and the brushes press horizontally against it, as may be seen from close in-

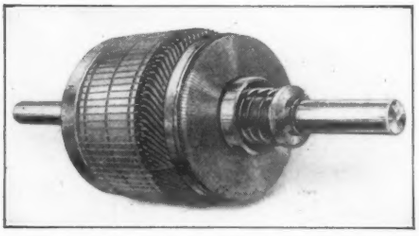


FIG. 367. ROTOR OF CONSTANT-SPEED SINGLE-PHASE MOTOR SHOWN IN FIG. 365. COMMUTATOR END

spection of Fig. 366, and these brushes are connected together electrically by the metal collar to which the brush holders are bolted. The brushes are therefore practically short-circuited, and they are so spaced with regard to the stator field poles as to produce a strong repulsion effect in the armature or rotor. This causes the motor to start and when it has nearly reached the regular speed, the brushes are lifted from the commutator and the commutator bars are all short-circuited; this changes the armature winding to what is practically the same (electrically) as a squirrel-cage rotor. Then the machine runs as an ordinary motor.

1131. *How are the brushes lifted and the commutator short-circuited?*

By a centrifugal governor which works against a spring. The governor weights are located within the rear end of the rotor spider, as shown in Fig. 368. By means of levers and links the governor weights slide the brushes away from the commutator and at the same time press a short-circuiting ring against the back face of the commutator, connecting all the bars together.

1132. *How does the governor mechanism move the brushes away from the commutator?*

A barrel slides along the shaft under the influence of the governor weights and the opposing spring; the governor weights move this barrel toward the commutator end of the shaft and the spring moves it in the opposite direction. The collar to which the brush holders are bolted is

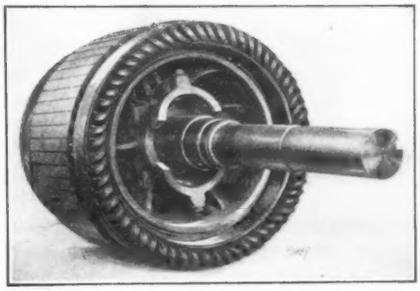


FIG. 368. PULLEY END OF THE ROTOR SHOWN IN FIG. 367.

cup-shaped, as shown in Fig. 369, and inside this collar a brass ring "floats" between the ends of the brush-holder fingers (which project into the cup through slots) and the end of the sliding barrel on the shaft. When the speed is high enough for the centrifugal force in the governor weights to overcome the opposing spring, the barrel is pushed against the ring in the brush-holder collar and the ring, pressing on the ends of the brush-holder fingers, pushes the brushes away from the commutator. The

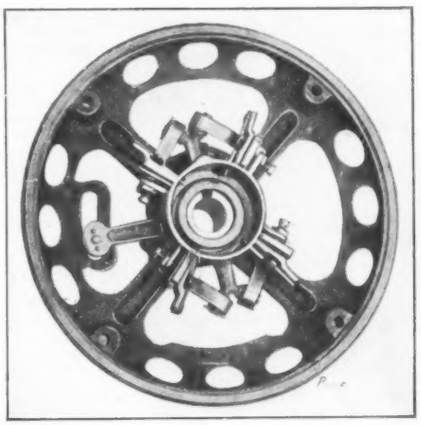


FIG. 369. BRUSH RIGGING OF CENTURY MOTOR

brush mechanism here shown is the one used on the Century motor, illustrated in Fig. 370.

1133. *How is the stator winding of this type of motor arranged?*

Exactly like that of an ordinary single-phase induction motor. Fig. 370 is a picture of the stator and rotor of the Century motor, from which it is evident that the stator core consists of slotted rings mounted in a circular frame or housing, and the winding is of the distributed type used in all induction motors of appreciable size. The machine here illustrated has four groups of coils which produce four magnetic poles on the inner face of the core.

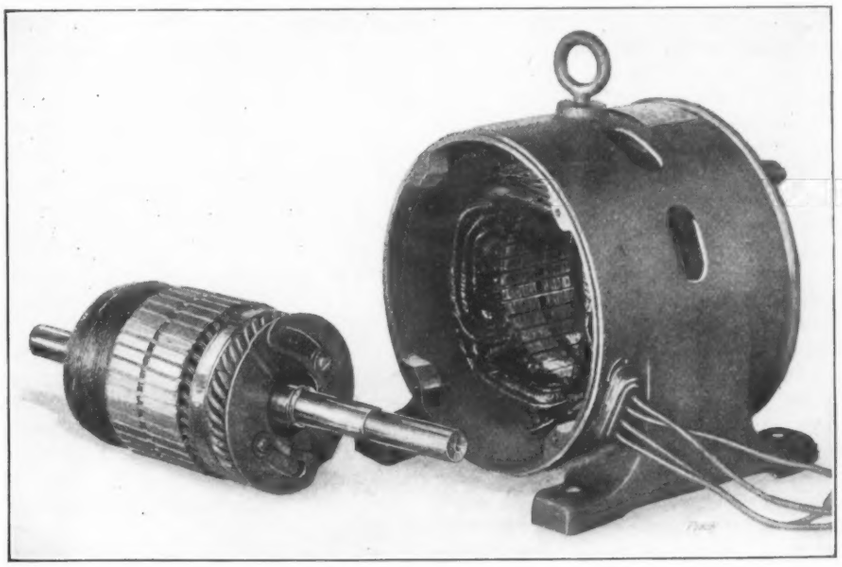


FIG. 370. THE CENTURY SINGLE-PHASE MOTOR

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Combination Piston Rod Packing

The following tells of a trouble I had with a badly scored piston rod on a locomotive.

Being a long way from the shop on a logging road, I had to pack the piston every night and then could not see for the steam that leaked out of the stuffing box. I had some graphite which I mixed into a stiff paste and then put in a round of ring packing in the stuffing box and filled the stuffing box full of graphite, put in another round of ring packing and screwed the gland up tight. The gland was then removed and more graphite put in, followed by another ring of packing. I had no more trouble for thirteen months and the packing was still in the box when I left the job.

J. A. McQUEEN.

Cheboygan, Mich.

Economic Boiler Feeding

An open heater is at its best when so designed and operated that all of the condensate from the heating system is returned to the boilers, and the amount of make-up water is reduced to the minimum. These conditions give the water the highest temperature possible with an open heater, unless live steam is used. And these conditions can best be obtained when a variable-speed pump is used with a variable delivery to feed the boilers, the speed or delivery of the pump to be controlled by a float in the heater connected to the pump governor or delivery-control valve, and not by connecting a float in the heater to the inlet or make-up water valve and regulating the speed of the pump by hand.

While the amount of condensate returned to the heater in an hour cannot equal the amount of water evaporated in the boilers in an hour, the maximum flow will raise the water level in the heater until it runs over the overflow and is lost if the speed of the pump is controlled by hand or by a feed-water regulator connected to a float in the boiler. While the periods of maximum flow are not long enough to raise the water level in the boilers perceptibly, owing to the larger area affected when the pump is controlled by a float in the heater, they are long enough to run a large quantity of water to waste via the overflow when the pump or water taken from the heater is not controlled by a float in the heater, owing to the comparatively small storage capacity of the ordinary open heater. Where the float in the heater is connected to the inlet valve, the make-up water is shut off altogether during maximum flow, and is admitted in so large a quantity during minimum flow that it has no time to be heated in the steam or trap space above the hot water but falls to the bottom, cooling the hot condensate in the heater. When the float valve in the heater is connected to the pump governor, the make-up water may be admitted continuously or nearly so. The fireman, having a mark on the inlet-valve wheel and only changing the amount, admitted slightly to keep the water level nearly constant in the boilers. In this way the make-up water has the longest possible time to remain in the trays and mingle with the steam in the upper part of the heater. The spasmodic flow of condensate from the heating system to the open heater is accounted for by the fact that nearly all heating systems contain pockets and water seals and in hotels, guests are opening and closing radiator valves at all times, traps are dumping and any slight change in pressure will change the flow from minimum to maximum. If the valve in the engine-exhaust pipe to the heater is nearly closed, as it often should remain, the condensation in the heater caused by admitting cold make-up water irregularly will cause a variation of pressure in the heater and at times quite a vacuum is formed, thus inducing an increased flow of condensate.

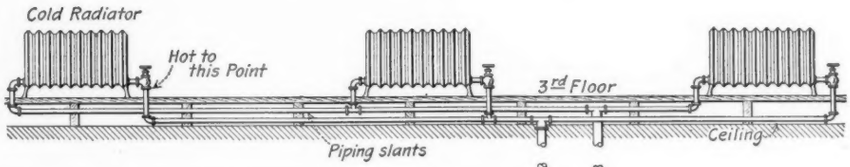
From the above it will be seen that a belt-driven plunger pump should never be used with an open heater, and if any constant-speed pump is used, we have a very undesirable and wasteful combination, unless the amount of water taken from the heater can be regulated by a float in the heater. There may be such an accessory on the market but I have not as yet seen one or an advertisement of one in any mechanical paper. A boiler-feed regulator might be attached directly to the heater and its motion reversed, so that as the water level in the heater rises, the main discharge from a centrifugal pump would open, and as the water level in the heater fell, the discharge from the pump would be throttled down. This would be a departure from any equipment I ever observed and, I think, from general practice.

C. E. BASCOM.

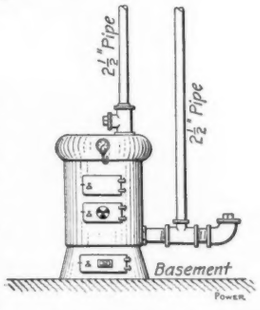
Worcester, Mass.

Radiator Failed to Heat

I would like to know what other engineers think of a radiator trouble in a heating system I recently installed.



PIPING OF RADIATORS



On the first and second floors, all of the radiators heat up nicely, but the three radiators on the third floor, which were put in later, did not heat satisfactorily.

When putting in the pipe to these radiators I tapped the feed pipe for a 2½-inch riser and also a 2½-inch pipe to the return pipe and carried them through to the third floor, and then branched off to each radiator with a 1¼-inch pipe, as a feeder, and a 1¼-inch pipe to each radiator for the return piping. On getting up steam two of the radiators heated up nicely but one failed to heat at all. The feed pipe to the radiator that did not heat was hot up to the valve, but the radiator remained cold.

I would appreciate the advice of engineers who have had experience along similar lines.

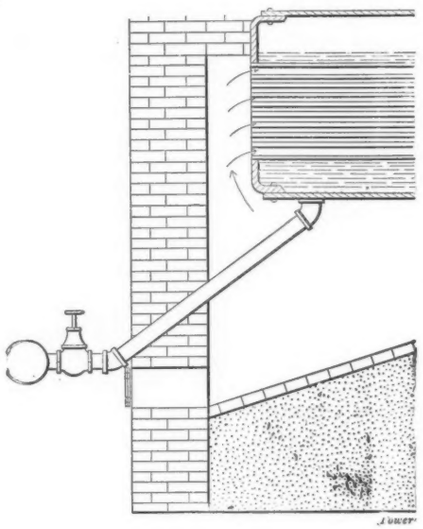
E. L. MORRIS.

Salem, Va.

Boiler Blowoff Pipe

The illustration shows the design of the blowoff pipe of my boiler, which I consider far ahead of anything I know of.

A close nipple is secured in the boiler



BLOWOFF PIPE

sheet and a 45-degree ell screwed onto it. A length of pipe reaches just through the rear wall and another 45-degree ell is screwed to the end of the pipe. The valve is connected as shown to the main blowoff pipe.

A. W. FREDRICKSON.

Willits, Cal.

Moisture Caused Trouble

A few years ago I took charge of a plant located at a coal mine. The boilers were each fitted with a dome and a 5-inch steam connection from the top of the dome to a 10-inch header, which extended across the engine room.

Steam was taken from this header through 6-inch outlets to each engine and a third outlet had been provided for a future installation in the engine room.

I was informed that the generators had been giving a great deal of trouble from sparking at the commutators, which proved to be correct, for I never saw such a display of fireworks as these machines were capable of exhibiting when carrying a load.

It was necessary to sandpaper the commutators two and three times a day and turn them down about every ten days.

I was also informed that there had been trouble with water in the engine cylinders and to overcome this they had connected a 6-inch pipe to the extra outlet in the header, and after turning downward this pipe extended below the floor level and ran out near the door, where it was reduced to 1 inch and fitted with a valve which was left slightly open to keep the pipe cleared of water.

This drip was located between the boilers and the first engine. Where it made connection to the header a very bad steam leak existed. As the weather was cold, and the engine room likewise, there was a great deal of moisture precipitated in the engine room from this leak. I wanted to take this pipe down at once, but the superintendent said No! very decidedly. Finally, one cold morning when the moisture was more in evidence than usual, I remarked to the fireman that the pipe was coming down that evening even though it cost me my job; and down it came. The outlet was blanked, thus stopping the steam leak.

In a short time I noticed that my generators were giving less trouble than formerly and they continued to improve until they finally got back to normal operating condition.

Then I took a tumble—the machines had been saturated with moisture and as they gradually dried out the trouble disappeared until finally all was once more in good shape, but the repairs to one armature which were necessitated by the work of that steam leak cost $600. Further, I never had any more trouble with water in the cylinders.

In this same plant they were using about twelve barrels of engine oil per year when I took charge of the job. After some persuasion I induced the superintendent to invest in an oil filter, and we used less than three barrels of oil that year.

A. RANSOM.

Wheeling, W. Va.

Air Pump Cleaned the Boiler

There are four boilers in the plant where I am employed and it was desirable to inspect three of them one Sunday. Accordingly they were cut out of service Saturday night and cooled ready for the inspector. When he came he could not go into the boilers, they were so filled with hot vapor.

I cut out the boiler that was under steam from the others and opened the throttle valve in the engine room and freed the main of steam. Then I opened the steam valve on the head end of the cylinder and disconnected the exhaust valve on that end and did the same on the low-pressure cylinder. The independent air pump was started and the stop valve on the first boiler to be inspected was opened, and inside of five minutes the inspector was inside of it. When he got through with that boiler I opened the valve on the next two, as required. Naturally the stop valves were made tight before the next inspection.

LEON KORZENESKI.

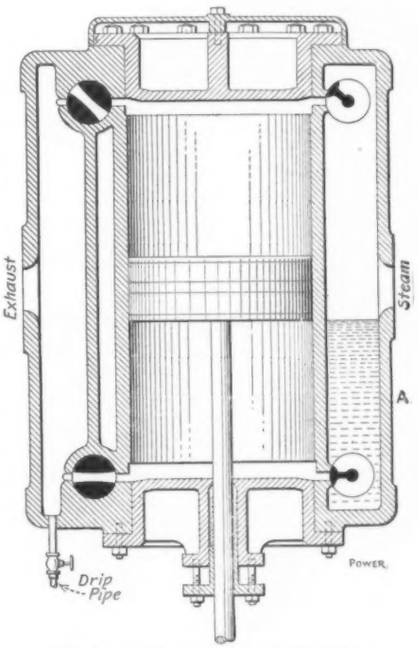
Fall River, Mass.

Water Wrecked the Cylinder

One night the low-pressure cylinder of an 18- and 36- by 36-inch vertical cross-compound Corliss engine, running at a speed of 135 revolutions per minute, was wrecked. The engineer on watch at the time said that there was a very light load on the engine prior to the crash, and that the receiver pressure kept going up until it reached 30 pounds. He found upon investigating that the crank-end valve on the low-pressure cylinder had not been picking up, owing to worn catch blocks. When he made the blocks engage, the cylinder head was knocked off with the flange. The cylinder was also cracked in several places.

At first it was thought that water accumulated in the receiver, and was taken over to the low-pressure cylinder, but the receiver trap was found to be in good working order and there was no chance for an accumulation of water there. It was reasoned that, owing to the high receiver pressure on one side, and a 26-inch vacuum on the other, and the valve not hooking up, considerable condensation had accumulated at *A* in the sketch.

When the valve was made to hook up,



WHERE WATER ACCUMULATED

the high receiver pressure forced the pocket of water through the lower valve, under the piston, which knocked it off the rod, and the next stroke brought the piston up against the head, which knocked it off.

THOMAS SHEEHAN.

Pittsfield, Mass.

Emergency Pump Packing

A short time ago the packing in the water end of our boiler-feed pump became so badly worn that it would no longer supply the boilers. As I had no packing of the proper size on hand, and the pump was the only means of supplying the boilers with feed water, I decided upon the following plan:

After carefully removing the old packing, I took some new tin and made a sleeve to fit nicely around the water piston.

After slightly softening the old packing, by putting it in hot water, I replaced it and found that the tin sleeve made it fit nicely. The pump was put into service and it ran two weeks until new packing arrived.

JOHN C. PITTS.

Cherokee, Okla.

He Got an Increase in Pay

Several years ago I went to work for a wood-working company in northern Michigan. Before I took charge of the steam plant, which consisted of one 54-inch by 14-foot shell boiler and a 10x16-inch slide-valve engine, they had one man firing and another cleaning the shop, bring refuse into the fire room and acting as a helper. These two men were paid $1.25 per day, and another man was paid $2 a day to look after the engine, which was located about 50 feet from the boiler. This made $4.50 for wages and they were burning eight cords of 4-foot wood costing $1.50 per cord, or $12, a total daily expense of $16.50.

I did the work of three men, except cleaning the shop. I started in for $1.50 a day and a promise of a raise, and I never got such a roasting in my life as I got the first day, firing with 4-foot wood. I knew something was wrong with the engine, but I did not want to stop to investigate until night; but at 4 o'clock I was all in and stopped the engine, took off the steam-chest cover and found the lock nuts on the valve stem loose and the valve sliding ¾ of an inch on the stem.

I got the valve centered, but on turning the crank to the center, I found the valve had no lead until about one-third stroke. I got busy with the eccentric, and moved it around until I had 1/32-inch lead with the crank on the center. When the engine was started the men all ran out of the shop for, instead of 165 it was making 247 revolutions per minute. I soon got the governors set for 220, the speed wanted. I next began burning coal that the former engineer said could not be burned without shaking grates, and it required 2700 pounds for 10 hours. Coal cost $3 per ton, or $4.05 for the day, and my $1.50 made $5.55 against $16.50 they were paying before I came. Furthermore, I was giving all the power wanted for 10 hours a day, while before there was not enough power any of the time, and the engine had to be shut down several times a day to get up steam, which made a difference of at least $100 per day in the output of the factory.

After my ten days' trial, I got my increase in pay and my experience since has proved it to be a typical engineers' raise. I saved the company $10.95, increased the output $100 a day and I got a raise of 25 cents a day.

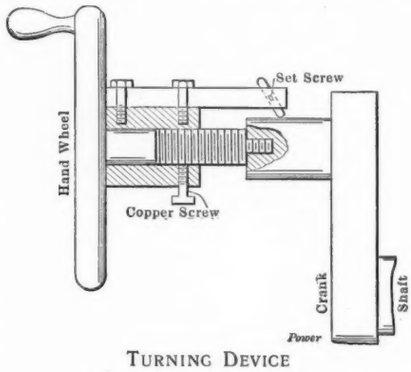
J. R. MORTON.

Detroit, Mich.

Device for Turning a Crank Pin

The accompanying sketch illustrates a device that I made to true a crank pin. On taking charge of my present plant, I found the crank pin on the ammonia compressor in very bad shape. It had been allowed to get hot and was badly cut and scored, and it was almost impossible to keep the bearing cool.

On calipering the pin I found that it was not only badly cut, but that it was out of round 3/32 of an inch. The diameter of the pin was 4⅞ inches, with a bearing 5 inches long. I took a piece of 1 13/16-inch shaft, 9 inches long, and got



TURNING DEVICE

one end turned down and threaded to screw into the end of the crank pin, 1 inch, as shown in the accompanying sketch. A fine thread (24 to the inch) was cut on the remaining part of the 9-inch pin. A sleeve was made to fit over the shaft, and a copper set screw passed through the sleeve to tighten on the thread.

A piece of ¾-inch square steel was attached to the sleeve with two set screws, and a slot was provided near the end to hold the cutting tool that was secured by a small set screw. A small solid balance wheel fitted with a handle was bored out to fit on the sleeve, which completed my apparatus.

Having all my toggles together, all was ready to go to work on Sunday morning, and with one assistant I turned up the pin and made a splendid job of it in about three hours.

The only mistake that I made in constructing my machine was that the feeding thread was a little too coarse.

After removing the machine from the pin I took two pieces of hard wood of the proper width and about 18 inches long, bolted them together and then bored a hole through them. Then emery cloth was tacked in the bore, the device was put in place and the pin smoothed up.

The boxes were rebabbitted and scraped, which completed the job.

WILLIAM G. WALTERS.

Stratford, Can.

Making Engineers

In almost every issue of POWER one reads about engineers' hours, engineers' wages and engineers' associations, but I cannot recall seeing any article on making engineers.

When I took charge of my present plant, I had fourteen men under me and not one of them subscribed for an engineering magazine or devoted any time to studying engineering subjects. It took me but a short time to find out that they were ignorant of the most elementary parts of steam engineering.

I suggested to my assistant engineers and firemen that they subscribe for POWER and other magazines, which they cheerfully did. I also suggested that they procure "Power Catechism," and showed them my own well worn copy and allowed each man to take it home for one evening's perusal, with the result that I placed five orders for the book. When any of my men asked me about any new appliance he saw advertised, I gave him stationery and the use of my desk at noon to write for a catalog and particulars.

At the end of one year eight men have procured engineer's licenses of various grades, two have left my employ and are running a plant of their own, three are studying hard for fireman's license and three are still in the same old rut, only wishing for 6 o'clock and the largest schooner of beer in the nearest saloon.

Where do I benefit and what recompense do I get for spending my evenings with my men? First, I have a thoroughly reliable crew of eleven men, and, with everyone trying his best to improve conditions in the plant it is kept up in better shape for less money, although the men have been given an increase of 25 cents per day. Second, I am a more uptodate engineer, as I continually have my memory refreshed, for when my men ask me a question I cannot answer I reply, I do not know but I will find out.

Now, some of you chief engineers get down off your "high horse," go down to the fire room and explain to your firemen that brains in the boiler room, as elsewhere, are worth more than muscles, and I will venture to predict that you can operate your plant for less money and with more satisfaction.

WILLIAM T. A. FAULKNER.

Seattle, Wash.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Pumping Problem

In the November 15 issue of POWER, Mr. Ellethorn contributes a pumping problem for which I offer the following solution:

Briefly, his problem is as follows: A 6x12-inch duplex pump, driven by a 12-horsepower engine, pumps 235 gallons of water per minute, through a 4-inch discharge line, which runs horizontally 200 feet from the pump, then vertically 200 feet and discharges into a tank. The water is drawn from four open wells, located 100, 110, 120 and 150 feet from the pump. The water level in these wells, is 10, 12, 18 and 22 feet respectively below the ground. The main suction pipe is 5 inches in diameter, and the risers from the wells, all of which terminate in the main suction line, are of 2½-inch pipe. In the absence of any data to the contrary, I assume that the pump and suction line are at ground level.

The discharge, which is given as 235 gallons per minute, is equal to

$$\frac{235}{60 \times 7.48} = 0.523 \text{ cubic foot per second}$$

The problem is to find how much of this comes from each well.

Numbering the wells 1, 2, 3 and 4, in the order in which they are mentioned above, it is first assumed that all of the water comes from well No. 1, in which the water level is 10 feet below the ground or datum. This water is lifted against, not only a static head of 10 feet, but a friction head, which is given by the following equation:

$$\text{Friction head} = \frac{4fl}{d}\frac{v^2}{2g}$$

wherein

v = Velocity of water in pipe in feet per second;
g = Acceleration due to gravity = 32.2 feet per second;
d = Diameter of pipe in feet;
l = Length of pipe in feet;
f = An experimentally determined coefficient, depending not only upon the velocity of the water and diameter of the pipe, but also upon the condition of the pipe as regards corrosion, etc. A clean iron pipe is assumed in this case.

The area of the 2½-inch pipe equals

$$\frac{\pi}{4}(2\tfrac{1}{2})^2 = 4.92 \text{ square inches} = 0.034 \text{ square foot}$$

The velocity in the pipe equals

$$\frac{0.523}{0.034} = 15.38 \text{ feet per second}$$

For a clean iron pipe, 2½ inches in diameter and a velocity of 15.38 feet per second, Fanning gives a value for f of 0.00580.

Substituting these values, the friction head is,

$$\frac{4 \times 0.00580 \times 10 \times (15.38)^2}{\frac{2\frac{1}{2}}{12} \times 2 \times 32.2} = 4.12 \text{ feet}$$

The total head (up to the 5-inch main suction pipe) is

$$10 + 4.12 = 14.12 \text{ feet.}$$

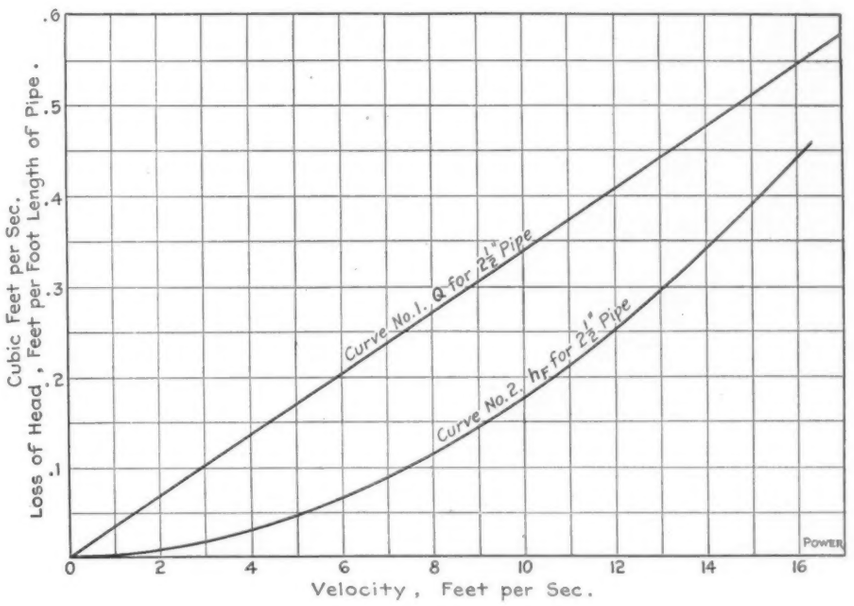
This being greater than the 12-foot static head of well No. 2, indicates that some water is drawn from that well; but no water will be taken from wells Nos. 3 and 4, because their static heads (18 and 22 feet respectively) are greater than this.

Let

Q = Total flow (0.523 cubic foot per second);
Q_1 = Flow in riser No. 1;
Q_2 = Flow in riser No. 2;
h_{F_1} = Loss of head due friction in riser No. 1, expressed as feet per foot of length;
h_{F_2} = Same for riser No. 2.

The problem now is to divide Q or 0.523 cubic foot per second between wells Nos. 1 and 2, so as to balance the following equation, which expresses the condition of equilibrium:

$10 + 10\ h_{F_1} = 12 + 12\ h_{F_2}$ + *friction head in 10 feet of 5-inch main suction pipe due to the flow of Q_2 cubic feet per second*



CURVES SHOWING VOLUME OF WATER DELIVERED AND LOSS OF HEAD

This problem necessitates using the "cut and try" method, that is, assuming a certain division of the 0.523 cubic foot per second and finding the resultant friction heads, until such values are found as will balance the above equation.

To save the work of solving the long formula for friction head for each assumption, curve No. 2 is platted, with head lost in friction per foot of length of pipe as ordinates and with the velocities as abscissas. The variation of the coefficient f with velocity is taken into account in platting this curve. Curve

No. 1 is that of cubic feet per second platted to velocity. All values are for 2½-inch pipe.

Assuming for the present that the friction loss in the 10 feet of 5-inch main suction pipe between wells Nos. 1 and 2 is negligible, the equation of equilibrium becomes,

$$10 + 10\,h_{F_1} = 12 + 12\,h_{F_2}$$

Assume that $Q_1 = 0.400$ and $Q_2 = 0.123$.

Referring to the diagram, pass horizontally across the line $Q = 0.400$ until it intersects the straight line, thus obtaining the velocity. Dropping vertically down this velocity line until it intersects curve 2, then horizontally to the scale at the left, we find,

$$h_{F_1} = 0.245 \text{ and } h_{F_2} = 0.025$$

Substituting in the equation of equilibrium,

$$10 + 10 \times 0.245 = 12 + 12 \times 0.025$$
$$12.45 = 12.30,$$

which indicates that the assumed value of Q_1 is too large.

Trying again with $Q_1 = 0.390$ and $Q_2 = 0.133$, from the diagram we find,

$$h_{F_1} = 0.233 \text{ and } h_{F_2} = 0.029$$

and our equation of equilibrium becomes,

$$10 + 10 \times 0.233 = 12 + 12 \times 0.029$$
$$12.33 = 12.35.$$

This being sufficiently close for our work, we will say that 0.390 cubic foot per second comes from well No. 1 and 0.133 cubic foot per second from well No. 2.

Now, knowing the value of Q_2, we must figure the friction loss in the 10 feet of 5-inch main suction pipe between wells Nos. 2 and 1 and see if our assumption that it is negligible, is sustained.

The area of the 5-inch pipe equals 0.136 square foot and the velocity in the 5-inch pipe is

$$\frac{0.133}{0.136} = 0.974 \textit{ foot per second}$$

For this velocity and a 5-inch pipe, Fanning gives $f = 0.007$. Substituting in the formula,

$$\textit{Friction head} = \frac{4 \times 0.007 \times 10 \times (0.974)^2}{\frac{5}{12} \times 2 \times 32.2}$$
$$= 0.00949 \textit{ foot}$$

which is negligible.

The pump or delivered horsepower is equal to the weight of water pumped per minute multiplied by the total head pumped against and divided by 33,000.

The total head is made up of four items, as follows:

(1) Discharge head = 200 feet.

(2) Friction head in 400 feet of 4-inch discharge pipe.

(3) Friction head in 100 feet of 5-inch main suction pipe.

(4) Static and friction heads (up to the main suction pipe) = 12.35 feet.

The manner of finding items (2) and (3) is exactly the same as that previously used, employing the formula,

$$\textit{Friction head} = \frac{4\,f\,l}{d}\,\frac{v^2}{2\,g}$$

using the proper values of f, as determined by the velocities and sizes of pipes. Item (2) comes out equal to 16.23 feet while item (3) proves to be equal to 1.41 feet.

Hence, the total head is,

$$200 + 16.23 + 1.41 + 12.35 = 230 \textit{ feet.}$$

The weight of the water pumped per minute is,

$$235 \times 8.34 = 1960 \textit{ pounds,}$$

8.34 pounds being the weight of one gallon.

The pump horsepower is,

$$\frac{1960 \times 230}{33{,}000} = 13.66 \textit{ horsepower}$$

T. B. Hyde.

Ithaca, N. Y.

Economic Engineering

With so many past records to uphold Power in its editorial in the September 27 issue, it seems superfluous to make additional comment on this subject. The argument offered by R. L. Rayburn in criticism, in the November 22 issue, however, makes further annotation necessary. Organization heads with manifold duties of office cannot take the part of the economic engineer; past performances have indicated this, and the particular type of the former which he depicts is considerably in the minority. The efficiency engineer called in on certain work possesses knowledge of many plants; the local superintendent has definite data on one—his own; the information that Mr. Rayburn mentions as being in the power of the superintendent becomes the property of the efficiency engineer; this is what he is placed in his position for—to investigate and learn actual existing conditions; he does not go blindfolded to his work. To afford efficient production his initial expenditures for new equipment may be large; he may change the system of the entire plant for future betterment—the results are manifested over a period of time, inclusive of interest on investment and depreciation; his arguments are based over a wide territory and, as Power states, he is not prejudiced. Is it not reasonable then to suppose that the economic engineer is in a far better position to offer suggestions for efficiency than the "man on the job"? The present Santa Fé Railroad system stands as a notable example of what an efficiency engineer can accomplish. The average superintendent, as found, is greatly in accord with keeping all expenses down—this is his province; in many instances (taken from actual experience) a superintendent has refused an installation which later the efficiency engineer has recommended.

I am under the impression that the superintendent is usually considered as an employer, and Mr. Rayburn contradicts his statements in noting, "I have found a great deal more unwillingness on the part of employers to furnish new equipment with which to improve the methods of operation, than unwillingness on the part of operators to break away from old established customs."

Efficiency work in its various branches is and has been for some time past a paramount issue with leading technical publications; the great results achieved, made known through this channel, leave no doubt in the mind that "the economic engineer is in a much better position to produce an effective solution of the problem" than any member of an organization, and that he is here to stay.

L. R. W. Allison.

Los Angeles, Cal.

Knocking Slide Valves

In the November 1 issue of Power W. H. Keller gives an account of trouble with a valve rattling or knocking.

I have had the same trouble with several engines. In one of these engines the pressure plate was held in place with two coil springs which rested over pins, and there appeared to be no cause for the trouble other than that the spring had become slightly weakened by the heat of the steam. Washers were put on and the rattle stopped.

In another case the trouble was with an engine which always ran well in warm weather, but when it was cold the valve rattled very badly. Owing to a very large heating system it was necessary to carry about 8 or 10 pounds back pressure on the heating system in order to heat the buildings. This high back pressure made the compression run up to about 10 or 15 pounds above boiler pressure. This trouble was also stopped by putting washers behind the spring.

Many automatic shaft-governed engines give trouble when running with a light load on account of the high compression, which occurs with a very early cutoff. This high compression not only makes the valve and pressure plate rattle, but often causes the engine to knock in the bearings. If the exhaust lap be trimmed off to remedy this, the compression will not be high enough when the engine is running under a heavy load. This difficulty may be overcome by running a pipe containing a check valve from the cylinder drain across to the steam-chest drain, or to any opening in the steam chest. The compression then cannot run above boiler pressure because the check valve will relieve it and let any excess steam return to the steam chest, but will prevent any steam being admitted except through the valve.

R. L. Rayburn.

Kansas City, Mo.

Leakage Past a Piston Valve

It is true that the leakage past a solid plug or piston valve is a hard matter to determine, but that there is leakage is well known. The amount depends on many things; probably the first is the quality of the material of which the engine was built, the second, possibly, the accuracy with which the engine was built and third, the care with which the engine is handled.

Many builders claim tight piston valves, yet they design these on the expansion principal, so that a valve can be expanded or adjusted to compensate for wear. With some rectangular plug-valve engines, such as use a much modified Sweet valve, an adjustable pressure plate is used; this must be for the purpose of taking up wear or preventing leakage past the valve. From operating experience as well as building, I know that when there is motion there will be wear, and unless we provide amply for such wear we are sure to find leakage. Many of the makers of engines having the Sweet valve could better their machines by carrying out the inventor's ideas—plenty of travel and plenty of surface means more life and a tighter valve.

Experience teaches that few engineers will take pains and care to keep rebuilding an engine so as to maintain a steam-tight valve, but instead, most of them allow the coal bill to run away with itself. The thing to do is to care for the machine properly, testing it at intervals for leaks and setting up the pressure plates so that leakage is reduced to the minimum; much coal can be saved in the engine room in this way. The steam-tight engine is a more difficult thing to find than many engineers think. Engineers should make more frequent tests so as to see that their engines are not leaking. This is just as important as locking the "cash drawer" and it is not for the want of knowledge upon the part of the operating engineer that tests are not made more often. Many engineers are past master machinists, know how to use the hand scraper and let down a pressure plate with as much skill as the engine-shop man. Thousands of dollars can be saved by following this suggestion.

While many piston-valve engine men say that these engines do not leak, they would be very shy of putting up their own money on a bet. It is not a case of leaking or not leaking, examine your engine and see that the valves are tight; do this on behalf of the company you are working for.

In taking up the expansion-ring valve it is necessary to take it up slightly and allow it to run a while and then take it up again as in expanding the ring it changes the circle and has to find a new seat or bearing so as to become tight in the port. In testing these engines I have found many to leak, not only those of the horizontal type but also those of the vertical type in which the wear was less than in engines of the several marine types.

I have never been able to see but one advantage that the piston valve possesses, that is, the round piston valve. This advantage is that it runs light and is light on the governor.

To test an engine for leakage, place it on midcenter, disconnect the exhaust, if possible, remove both indicator plugs and turn on full steam pressure just as you would when starting. The fact that an engine runs well is no indication that the engine is not leaking. In some cases the engine that is leaking the most will be running the smoothest.

Only a few days since I had the opportunity of examining and measuring with standard gages a piston valve of the plug type and found that there was more than 0.033 of an inch play between the valve and the seat. The engine was of about 100 horsepower capacity, so one can imagine what the loss amounted to.

Frequent tests should be made. Engineers do not test and inspect enough; as a rule these matters are sadly neglected.

C. R. McGAHEY.

Baltimore, Md.

Underground Steam Piping

I note the answer given to a correspondent recently relative to underground steam piping. I have had a fair amount of experience along that line and rather doubt if the advice would apply to all conditions. With a gravelly ground which takes the water away the problem is fairly easy if your expectations are not too high. We have put the pipe in all the ways we could think of that promised success. Our ground is a water-tight clay which makes it a hard proposition. And, not only that, but in certain sections it is saturated with salt. The first pipe we put down was laid in a box and packed with cinders. As might be expected, this lasted only about six months; the sulphur in the cinders destroyed the pipe quickly.

Our next job was to put several hundred feet of return pipe from a steam-heating system in the ground. This was placed in a box of 2-inch plank and packed with mineral wool; the job was a rank failure. The ground held the water and the wool kept the moisture up to the pipe, causing a rapid corrosion. This job lasted one winter and was in bad condition when the steam was turned on the following fall. Mineral wool is not the best insulator for this line of work; it has a way of settling down in the box and leaving the top of the pipe exposed. We would not have had such poor results if the ground had been of a nature to let the water drain away. We realized that we had to get a better method and we tried two ways of protecting the pipe, both of which have been fairly successful.

A part of the pipe was placed in a box of 2-inch plank, as in the first case, except that it was not packed with anything and the pipe was supported in the center of the box by a cradle of iron rods that left it quite free to move lengthwise. This installation has been in nearly six years and has given no trouble at all. Of course, there is some loss by radiation, but probably less than if wet packing was in contact with the pipe. Several hundred feet of this same job was laid in a different way but with equally good results. In this case we wrapped the pipe quite loosely in two or three turns of tar roofing paper, wiring the ends. Around this we placed about 3 inches of mortar composed of cement and sand in the proportion of 1 to 3. This keeps the pipe in good shape and the roofing paper forms a core in the cement large enough to allow the pipe a free movement. I like this plan very well.

About three years ago we laid a 2½-inch pipe from the shop across the commons, 300 feet to the house. In this case we pitched the 2½-inch pipe down for a distance of 150 feet, then put in an expansion joint and a trap, raised the pipe size from 2½ to 3 inches and pitched it up to the cellar of the house. The extreme low point was over a sewer into which the trap discharged, all condensation from the radiators returning in the 3-inch to the trap. The system works well. The pipe is placed in a box of three thicknesses of ⅞-inch plank with two ½-inch air spaces and packed with pine shavings. Underneath the box is a 4-inch drain tile covered with gravel and over the whole is one thickness of tarred paper. This pipe has given no trouble whatever and we feel that it is fairly well insulated. The job was too small to pay for returning the condensation, especially as we had plenty of hot water for the boilers and a purifying system to remove the impurities.

Our last work was that of taking care of the returns from the heating system in a building 100x150 feet square and two stories high. Next to two side walls we made tunnels 2½ feet wide and 3 feet deep, to carry the main returns. The laterals are in cement ducts with joints in the cement so that the pipe can be got at with the least damage to the floors. We use a plain gravity system with return pipes of a size that allows their being only partly filled with water, thereby balancing the pressure on the system and allowing the air in the wall coils and radiators to gravitate to the receiver, where it is expelled through ample vents.

To my mind there is no really successful way of burying a steam pipe in the ground so as to have it last well. The only way is to place it in a tunnel where it can be kept in repair and properly insulated.

I have seen 10-inch mains taken up in a district heating system that were practically destroyed after three or four years' use. If pipe has to be placed in the ground, make the covering as near moisture proof as possible. Even then there will probably come leaks in the joints that will keep the insulation wet and cause its destruction if the pressure is high.

J. O. ELDER.

Anderson, Ind.

Handling Men

Much has been said in the columns of POWER in regard to the treatment of men employed in the power house.

To know just how to treat each and every man in a power plant is no easy task, for if you try to act fair with all, there is bound to be some who will not appreciate kind treatment.

The men of a certain class do not seem to know when they are well off; they kick and complain about their surroundings, their hours of labor, etc., and they are always complaining about not getting a chance. Yet, when their conditions are bettered they abuse them, and whenever a chance for a better job turns up they are not prepared to accept it. The question is, what is the best thing to do with these men.

Men who are ambitious and ever ready to acquire a better working knowledge of their business as engineers, firemen or oilers, do not as a rule find much difficulty in commanding respect from the superintendent or chief engineer, especially if they can show that they are awake on their job. It is only the men who have to be told to do every little thing around the plant, or the men who try to see how much time they can kill without being discovered who find it hard to get along with the operating engineer. A majority of subordinates do not fully understand the position that the engineer in charge is placed in; they do not or will not reason the matter out to see that the owner or manager holds the engineer responsible for everything pertaining to the engine room, and yet when the engineer thinks up ways and means for saving fuel, oil or supplies and divulges his little schemes to his helpers, nine out of every ten of these men criticize him as soon as his back is turned, for catering too much to the boss.

To my mind the positon of engineer in charge of any plant is no sinecure, and I can positively state that you must treat the men that you are responsible for in a manner best suited to them, based on personal observation of them.

If, as Mr. Levy says in POWER for December 20, a man finds fault simply because he wants it understood that he is IT, he certainly shows his lack of sense and cannot expect the men who work for him to have any confidence in his judgment.

Referring to the article submitted by Mr. Carr in the same issue, in which he says that he treats his men as he would like to be treated himself, I must say that I agree with him in this respect, providing he is dealing with the class of men who have brains enough to know that they are being treated right. Mr. Carr further states that we all make mistakes, which is all too true, but here, as in all other things, a lot of judgment is needed to decide whether or not the mistake is pardonable.

Certain men when given an inch will take a foot; that, to my mind, is a very true saying and if this class of man is not kept in his place there is no telling what else he may take.

Regarding his statement as to a man who is frank enough to say he is not familiar with this, that or the other thing, I would like to say that as a rule this kind of a man usually makes the one on whom you can rely most, owing to the fact that what he has learned has to a large extent been gained from the knowledge which has been imparted by you; the right kind of man will show his appreciation of this fact by faithful service as long as he is in your employ.

H. H. BURLEY.

Brooklyn, N. Y.

Introducing Solvents into Boilers

Under the above heading, Charles H. Taylor had an article in the December 6 issue of POWER in which he described his method of introducing solvents. I believe that it is better to feed the solvents in with the feed water, so that all the feed water will carry along with it into the boiler the required amount of compound necessary to precipitate the scale-forming matter contained in it.

One method of accomplishing the desired result is to have a small pipe connected into the suction pipe of the pump and extending up a little higher than the level of the water in the heater. The pipe should end in a funnel. Above should be mounted a tank large enough to hold at least a day's supply of the solvent used, dissolved in water. The outlet pipe from this tank should end in a petcock just above the funnel, so that the attendant can see and regulate the amount of the solution he is feeding. Of course, the above method will not apply where the feed water is supplied to the pump under city pressure, but as I never had that problem to solve I will leave suggestions along that line to those who have.

Where compounds are used that will act on the feed water below the boiling temperature and where an open heater is used, I introduce the compound into the inlet pipe to the heater, so that the compound can act on the water as it passes through the heater. The heater thus becomes a sort of a feed-water purifier. Under some conditions large quantities of scale-forming matter can be removed by the heater and if a heater is used that is easily cleaned there is a decided gain over the method of treating water after it leaves the heater.

On waters that soda ash has produced little or no effect outside of the boiler, trisodium phosphate has been found to act efficaciously even while the water is quite cold, so that by introducing this latter compound into the feed water before it enters the heater a large part of the scale-forming matter is precipitated and removed from the water before it enters the boilers.

G. E. MILES.

Salida, Colo.

Liquid Discharging Device

An article by Earl Pagett, on page 2196 of the December 13 issue of POWER, interested me a good deal, as I have had some experience with a somewhat similar device for emptying barrels.

Several years ago I conceived the idea of making a similar arrangement, but to start with I applied the air at a separate opening. My arrangement worked beautifully on several barrels. One day I got hold of a barrel with a very short chime and when the air pressure came on, the head came out of the barrel. Forthwith I lost all interest in that means of emptying barrels.

A. G. KNIGHT.

Omaha, Neb.

Lubricating Piston Packing

An article in the November 22 edition relating to a ring or sleeve between sundry rings of fibrous packing, with a hole in the said ring or sleeve through which oil is run by gravity onto the piston rod while it is in reciprocating motion, reminds the younger generation of engineers of their daddy's lectures that, say, a 40-horsepower stationary engine must have a cylinder diameter of, say, 14 inches and a stroke, say, 36 inches long—the longer the better and more effective—no cutoff and a speed of 50 revolutions per minute.

We wish to learn, and concede that we know very little, why it would not be well to utilize graphite instead, fed through a modern lubricator. Perhaps one reason has been the likelihood that graphite, mixed in oil for the purpose, would stop up or clog up the openings, which experience has proved to be so. Our idea is, however, to use graphite in connection with the lubricator in which the drops of oil pass over a bed of fine graphite, to the cylinder, lubricating the inside of the cylinder, the valves and, particularly, the *piston rod*, dispensing with the ring or sleeve for lubricating the rod and the packing.

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POWER

The Consumer Pays the Bill

Not many years ago the anthracite coal companies of Pennsylvania could market only their larger sizes of coal which was used largely for domestic purposes.

The smaller sizes now known as pea, buckwheat, rice and barley coal were dumped in great piles together with bone, slate and other refuse from the mines. These immense culm piles grew in number, and in some instances to almost mountainous proportions, but no attempt was made at that time to reclaim the fuel mixed with the noncumbustible matter.

Just when the burning of the smaller sizes of anthracite coal was begun is not definitely known, but many large power plants are now using buckwheat coal extensively as a fuel.

Naturally, the growing demand for the smaller sizes of anthracite coal has not been from a desire on the part of the power-plant manager to reduce the culm pile or to add profit to the coal producer, but that the cost of operating the steam plant might be reduced by using a cheaper fuel. Accordingly he has devoted much attention to experimenting and the training of his fire-room force in handling the cheaper grades of coal.

It did not require much urging on the part of the consumer to awaken the coal producer to the fact that there were thousands of dollars to be had almost for the picking up, and as a result washeries were built, old breakers remodeled and the reclaiming of coal from the culm piles became a most prosperous enterprise.

The demand at first was for the larger size of the buckwheat coal, which was cheaper than the pea and chestnut sizes, but the price was put up as the producer saw the demand had become permanent. This forced the consumer to either purchase a cheaper grade of coal or increase the cost of the manufactured product, and the cheaper grade was bought.

As the purchase price increased on a certain grade of coal, still cheaper and finer sizes were tried until barley, the smallest of all except "dirt," became the cheapest grade of anthracite coal that could be used.

Barley coal, until recently, has been selling for $1.50 per gross ton of 2240 pounds, f.o.b. vessels at Hoboken, N. J.; rice, $2; buckwheat, $2.50; and chestnut, $5. Each of these coals has been advanced in price during the past month at the rate of 25 cents a ton.

To one known company using rice and barley coal this increase will make a difference of about $40,000 yearly in the cost of fuel. There is no cheaper grade of coal to fall back on and the additional cost must be met.

It is not at all probable that the manufacturer will stand the increases in the coal bill, and as there is not much chance of decreasing the amount of coal consumed per year, the logical conclusion is that the consumer will in the end pay for it.

It is not the cost of reclaiming this coal from the culm pile that warrants a selling price of $1.75 per ton, as a ton of buckwheat coal can be washed and loaded in a car for something like 10 cents per ton. The balance of the cost price is divided between profits and transportation rates.

And the consumer, who has created a demand for a byproduct of a mine at one time thrown away, must now pay an increase per ton just because the coal producer determines to make a greater profit on coal that costs practically nothing to market, and because there is no substitute in sufficient quantity to supply a B.t.u. at an equal cost.

Impossible Boiler Performances

There are being circulated printed records of tests conducted by John R. Hilton at the plant of the American Printing Company, Fall River, Mass., upon horizontal return-tubular boilers, in which evaporations of over sixteen pounds of water from and at 212 degrees are claimed. Mr. Hilton is the master mechanic of the above named corporation and evidently believes that he obtained these results.

To evaporate a pound of water from and at 212 degrees requires 970.4 units of heat. To evaporate 16.69 pounds, as Mr. Hilton claims was done in one of his tests, would require 16,196 heat units.

Assuming that each pound of combustible makes twenty pounds of gas and that the gas leaves the boiler four hundred degrees above the room temperature, it would take some two thousand heat units to the chimney with it. Adding this to the heat put into the steam

it is seen that such a performance would call for a coal of over eighteen thousand British thermal units per pound of combustible, even allowing nothing for radiation; and no such coal has ever been mined.

At the time that this impossible performance is claimed to have been effected the boilers were fitted with a device known as the Cornell fuel economizer. This consists of a number of metallic retorts behind the bridgewall, into which steam is admitted, and it is claimed that the steam in passing through them is decomposed into its constituent gases, oxygen and hydrogen, and that it is the combustion of the hydrogen which supplies the extra heat necessary to obtain the high evaporation reported.

This claim has been exploded over and over again in POWER. Even if the steam is so decomposed it takes as much heat to decompose it as the gases produced will generate in combustion. When hydrogen is burned, two atoms of hydrogen unite with one of oxygen to form H_2O or water vapor—steam. The decomposition of steam into hydrogen and oxygen is a reversal of the process, and takes just as much energy in the form of heat as was produced, or will be produced again, by the reunion of the gases in combustion.

If those in authoritative control of the Cornell Economizer Company do not know this, they had better inform themselves as to the elementary principles of combustion before entering the market as practitioners in this line.

Natural Sources of Power

Man has often been called a tool-using animal, this seeming to be the only characteristic difference between him and other animals. But more than a tool user he is a power user and as civilization advances the per capita demand for power increases in geometrical ratio.

Scarcely a century ago the modest demands of each community were met by the utilization of the energy of small, rapid streams by the means of crude waterwheels built in place by the local millwright. In some instances the ebb and flow of the tide furnished the power needed by small industries and, where both waterfall and ocean tide were lacking, great canvas-covered wind wheels turned the stones that ground the grain for man and beast.

With the parallel development of the steam engine, electric transmission and the factory methods of production came increased demands for power for manufacture and transportation.

Steam has been almost universally used as the medium of transmission. But the steady increase in the price of coal has turned the attention of men toward the natural forces of wind and wave and their utilization in power production. "The wind that bloweth where it listeth" and the sea which is never still could if intelligently harnessed be made to furnish power at a rate far beyond the dreams of the wildest enthusiast.

But at what price per unit?

Some of the oldest mills in the country were and perhaps are today driven by wave power. Built before the steam engine became the common prime mover and costing little for upkeep they have, where equal to the demand, been continued in operation. An investment once made, the interest cost of the capital goes on forever, and it will doubtless be found on investigation that the interest on the investment in any of the old-time water or wind powers at prevailing rates would operate a steam plant of equal capacity and leave a margin of profit.

With the ever-increasing demand for power for every conceivable purpose it is not to be wondered at that every move tending toward the development of unused forces of nature should attract attention, but it "passeth understanding" that palpably inefficient and expensive methods of utilizing the rise and fall of the tides, the heat of the sun and the current of rivers beyond the reach of a possible market should find such ready support from even a guillible public.

No investor would buy land without having the title examined by competent authority on such matters. But the first successes of a Keely or a Carroll show that the professional promoter of any kind of a scheme to beat the law which affirms that action and reaction are equal and opposite, finds ready buyers for his wares.

No one should consider the investment of money in any enterprise to control and direct natural forces until he has paid a competent engineer to make an exhaustive examination of the proposed program.

A Pioneer

For his work in advancing condensing and compound-engine practice in this country, William Coutie, who died recently at Troy, N. Y., deserves attention from the engineering fraternity. Mr. Coutie was in his ninety-second year. He came to the United States from Scotland before he was thirty, and in 1849 he was working as a machinist at the Starbuck shops in Troy, then located close by the river. Near the shop was a coffee and spice mill doing a large business for those days and driven by an ordinary high-pressure noncondensing engine. He arranged to take the exhaust from this engine, placing a valve in the pipe which guaranteed that there should be no back pressure, and with this steam he drove a condensing engine which supplied him with power for a machine shop which he started in 1850. This was his sole source of power for ten years or more and it was an incontrovertible example of the economy of condensing.

He made a specialty of simple and compound steam engines, always condensing, and built quite a number for Troy and the immediate vicinity. The engines never proved to be what would be considered high-class machines, but they saved fuel and cost little for repairs. He was one of the first builders of "Troy laundry machinery" and did a general and repair trade, but never anything big, and discontinued business in 1899.

Mr. Coutie was spoken of as a scientist and had affiliations with some of the societies. He wrote a number of papers of a pseudo-scientific character which could scarcely be considered seriously. They all had the somewhat unusual merit of being short. His hobby for fifty years was the commutation of metals, and he is said to have died in the belief that this he had actually accomplished.

In utilizing exhaust steam that had previously been wasted, Mr. Coutie allowed his Scotch thrift to come to the front. In effect his engine was merely a low-pressure cylinder added to the engine in the spice mill, but for so early a period in steam-engine history, his work was ingenious to say the least, and he should be given due credit.

The following is a squib which appeared in one of the Pittsfield, Mass., papers on the day following the disastrous boiler explosion, described in the January 10 issue of POWER:

"When asked by the reporters for a statement concerning the exact cause of the explosion, Inspector McNeil spoke in full as follows:

"..... ...."

If an engineer takes a lively interest in all matters pertaining to his vocation he will be a successful engineer.

Some idea of the importance of apparently small things may be had when it is realized that in a 30,000-kilowatt plant one inch in vacuum represents a total of $14,000 in the operating expenses for one year.

With the water-power developments and the adaptation of the internal-combustion motor to all classes of power service, how long will it be before steam engines will be unfashionable?

San Francisco started the new year with an earthquake. That's nothing. Pennsylvania and Massachusetts had three boiler explosions just before New Years, and killed twenty men.

Low Pressure Steam Turbine

Osborn Monnett

At the works of a rubber-manufacturing company live steam at 40 pounds pressure, after being used in the vulcanizers, is utilized in a low-pressure turbine.

No installation better demonstrates the possibilities of the low-pressure steam turbine than does that of the Diamond Rubber Company at Akron, O. The power plant originally contained a 1500-horsepower, cross-compound, Corliss engine, direct connected to a 1000-kilowatt generator, the set running condensing. In addition there was a 250-kilowatt, tandem-compound noncondensing engine and numerous auxiliaries exhausting into the low-pressure system, which supplied the heating coils of the indirect heating system.

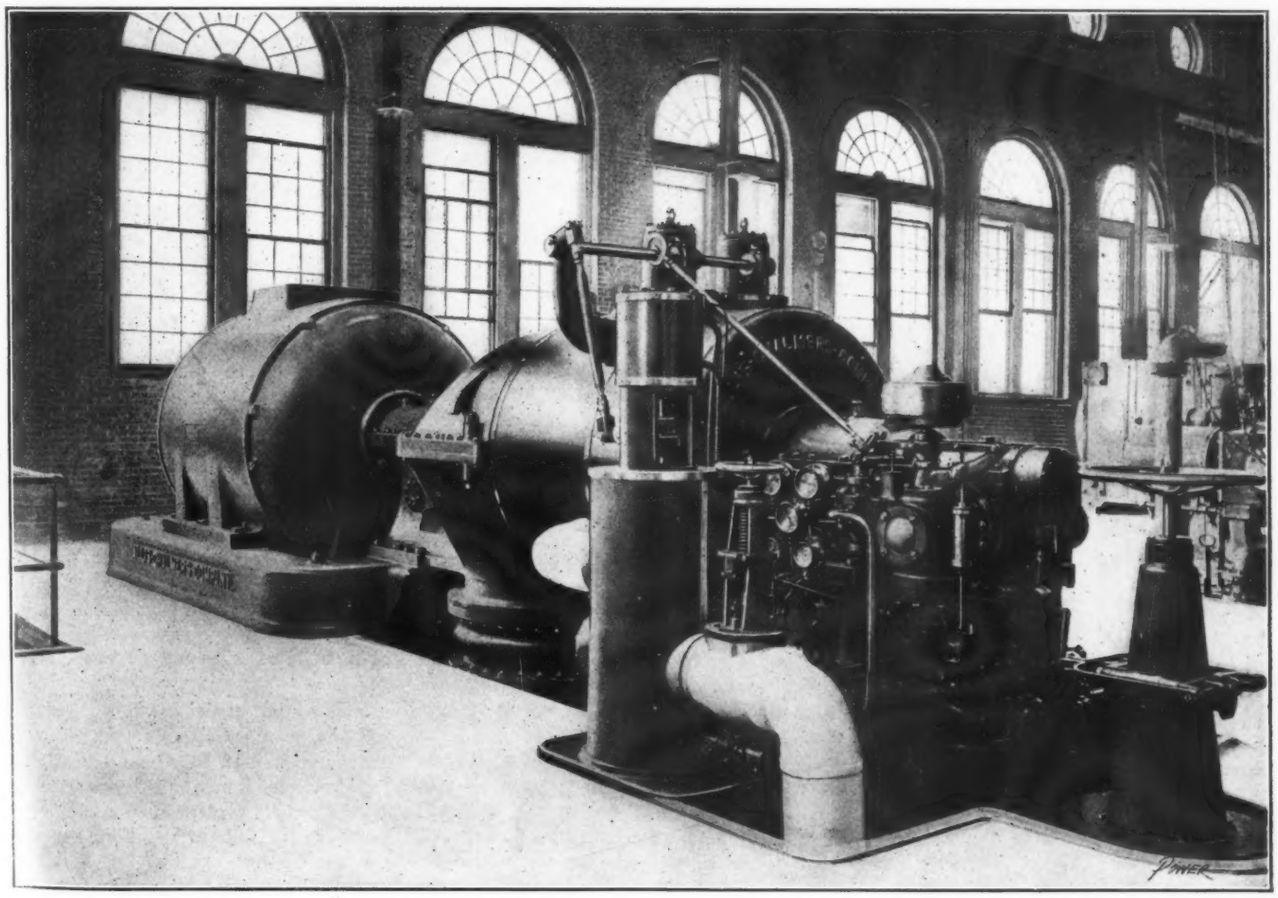
In the process of manufacturing rubber goods a large amount of heat is necessary, and at these works this is furnished by live steam at about 40 pounds pressure. Formerly this steam was considerably in excess of that used in the power plant itself; only a comparatively small amount of the exhaust steam available from the engines and the vulcanizers was utilized, while the rest was exhausted into the atmosphere. Realizing this loss and looking for a means to stop it, the idea was conceived of collecting all the exhaust steam in a large receiver which would serve as a source of supply to a low-pressure turbo-generator. Accordingly, this plan was finally worked out and a 1000-kilowatt, 25-cycle, two-phase, 240-volt Allis-Chalmers turbo-generator was installed to operate in parallel with the main generator.

The success that has attended this arrangement is apparent from the fact that even under extremely adverse conditions the turbine has been able to carry the entire electrical load, thus allowing the Corliss engine unit to be shut down.

One difficult feature of the installation was the selection of the proper condensing apparatus to meet the conditions existing. Due to the use made of the steam before it enters the receiver it carries a large amount of air. Also, owing to the source from which the condensing water is secured, it is impossible to obtain this at as low a temperature as would be desired. An Allis-Chalmers jet condenser with a special dry-air pump was finally installed. The circulating water and condensed steam are removed from the condenser by a centrifugal pump, driven by a small impulse turbine, the exhaust steam from this small turbine discharges into the main receiver on the inlet side of the low-pressure turbine and consequently does work through the complete range of pressure.

To handle the large amount of air that passes to the condenser, a 12 and 30 by 24-inch dry-air pump was installed; this is of the rotative crank and flywheel type, and has about twice the capacity that would normally be required for a turbine of this size.

Condensing water is obtained from the lock of an old canal just behind the power house, which also serves as a supply for other manufacturing plants. This lock also receives the discharge from all the condensers and, as it is comparatively small, the water soon becomes warm. During the summer months the temperature of the water frequently rises above 100 degrees Fahrenheit, yet the turbine carries its load successfully.



1000-KILOWATT LOW-PRESSURE TURBINE

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Compound Engine Balance

When a compound engine is said to be balanced, does it mean that the load is balanced between the cylinders or that the cranks are balanced so that the engine will run quietly?

C. E. B.

In a compound engine the load is balanced when it is equally divided between the cylinders. The engine itself is balanced when the inertia effect of the reciprocating parts is neutralized by weights on the cranks.

Number of Expansions

What is the rule for finding the number of expansions in any size of cylinder?

N. O. E.

The diameter of the cylinder has nothing whatever to do with the number of expansions. This is determined by the point of cutoff. The number of expansions is the reciprocal of the cutoff; that is, 1 divided by the fraction of the stroke completed at cutoff. If the cutoff is at ¼ stroke, the number of expansions will be 4, because 1 divided by ¼ equals 4. If the cutoff is at ⅓ of the stroke, there will be 3 expansions, and so on.

Size of Steam Chest

What is a simple rule for proportioning the size of the steam chest of a slide-valve engine?

S. S. C.

Make it no larger than is necessary to accommodate the valve and give room for the passage of what steam will be used.

Double Acting Pump

What is a double-acting reciprocating pump?

H. A. T.

One in which the piston acts in both directions, alternately for suction and discharge, drawing in the water at one end of the cylinder while discharging at the other.

Direct Acting Pump

What is a direct-acting pump?

P. D. A.

One in which there is no rotary or walking-beam motion. The piston movement is reversed by an impulse controlled by itself. The steam and water cylinders are in a direct line and the movement of the water piston is identical with that of the steam piston.

Steam Furnished by Compression

If an indicator diagram shows 85 pounds initial pressure and the compression runs up to 42 pounds, what proportion of the steam which fills the clearance space to initial pressure is furnished by compression?

S. F. C.

One cubic foot of steam at 85 pounds gage pressure weighs 0.2296 pound. The same volume at 42 pounds pressure weighs 0.1355 pound. Then

$$\frac{0.1355}{0.2296} = 59 \text{ per cent.}$$

of the steam in the clearance space furnished by compression.

Compound-Engine Valve Setting

How should the valves of a compound-condensing engine be set?

C. E. S.

The valves of condensing engines having the same duties to perform as those of noncondensing engines should be set the same. A slight improvement may be made in some cases by giving the low-pressure exhaust valves more lead than is common for a noncondensing engine.

Pressure in Condensing Engine

If the steam pressure in the boiler is 75 pounds and a condenser is attached to the engine, how much will it increase the pressure in the engine cylinder?

P. C. E.

The pressure in the cylinder will be the same as before the condenser was attached, but the difference of pressure on the opposite sides of the piston will be increased, because the condenser removes a part of the atmospheric pressure from the advancing side of the piston. This is equivalent to increasing the pressure on the other side and amounts in average practice to 10 or 12 pounds per square inch of piston area.

Racing in Compound Engine

When the load is thrown off of my compound-condensing engine it races. What is the cause?

R. C. E.

Incorrect valve setting or maladjustment of the governor. The connections between the governor and the valves should be so adjusted that when the governor is in its highest position the admission valves on neither cylinder will be opened.

Change of Cutoff

How can I change the point of cutoff on a Brown engine?

C. O. C.

By changing the load or the steam pressure. The point of cutoff is controlled by the governor and takes place at that point which will keep the engine at the right speed.

Condensing above Sea Level

At a hight of a mile, is the vacuum in an engine cylinder as effective as at the sea level?

C. S. L.

It is.

Legal Ownership of Patent

If, while working for another, I invent, make and patent a machine or tool, using his time, tools and materials, does the patent belong to him or to me?

L. O. P.

If a man working at a machine conceived a better way of producing the piece that he was making and got up an attachment to the machine for doing so on his own initiative it would be unreasonable for his employer to claim the rights to the patent because it was developed while the man was in his pay and perhaps used a pound or two of brass and steel.

If, on the other hand, an employer wanting a machine or process worked out, hires a man to develop it, he pays for brains and ingenuity and is entitled to whatever is evolved in that connection. Between the two cases there are many gradations, the equities of which are often difficult to settle.

The legal ownership of a patent is vested in the one to whom it is issued.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

New Method of Flanging Pipe

This method of flanging pipe by the cold hydraulic process was devised for the purpose of cutting down expense and eliminating the necessity for skilled labor, the latter being so essential to many of the methods now in use. A rectangular groove is first cut around the inside of the flange, which is then placed in position over the pipe as shown in Fig. 1. The die, consisting of a number of segments having projections corresponding to the groove in the flange, is then expanded by the hydraulically-driven tapered mandrel. Thus the flanging is accomplished, practically, in a single operation. A hydraulic chuck, which is shown in Fig. 2, and consists of six radial hydraulic pistons, is placed over the flange and takes up any radial strains produced by the mandrel. Each machine is fitted with an adjustable pipe rack and an attachment for bringing the flange faces exactly parallel, thus doing away with the necessity of refacing and at the same time permitting extreme precision in measurements. Another significant fact is that it is not essential for the pipe to fit closely the bore of the flange; and, when so desired, the flange may be put on at an angle with the axis of the pipe. By fitting a collar over the flange a flexible joint may be had the same as with a welded or rolled flange.

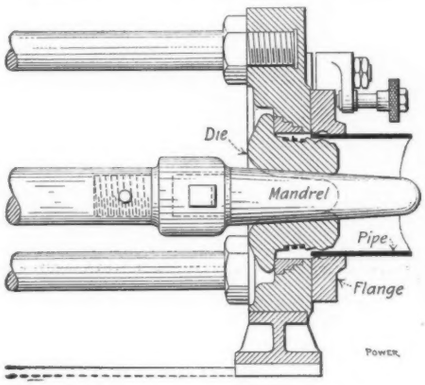


FIG. 1. PORTION OF FLANGING MACHINE, SHOWING FLANGE AND PIPE IN PLACE

Recently one of these joints was subjected to a severe test by being placed in service under superheat at a temperature of 750 degrees for six consecutive days, and twice each day a stream of cold water was directed against it. An examination of the joint at the end of the test revealed no signs of weakness.

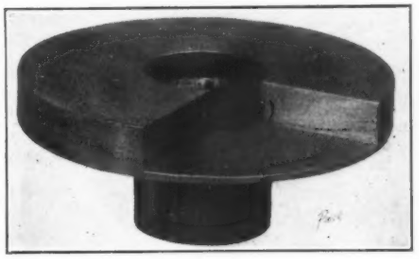


FIG. 3. FLANGE SHOWING FINISHED JOINT

At present machines are built to handle pipes from 2 to 20 inches in diameter and it is claimed that one man and a helper can flange forty 4-inch or twenty-five 8-inch ends in an hour. The process is applicable to either cast-iron, wrought-iron or steel flanges, and is allowed in the marine service by authority of the United States Steamboat Inspection Bureau.

The machines are built by the Patterson-Allen Engineering Company, of Jersey City and 2 Rector street, New York City.

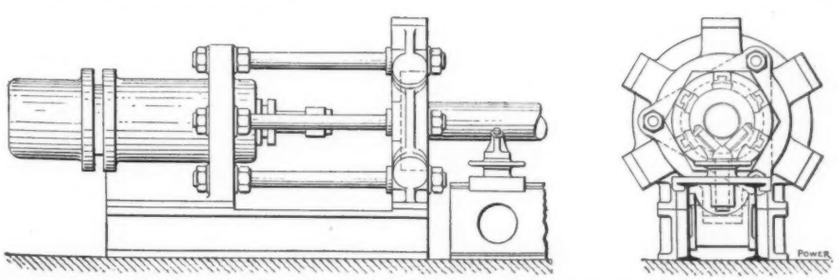


FIG. 2. PIPE SUPPORTED BY RACK AND HYDRAULIC FLANGE CHUCK IN PLACE

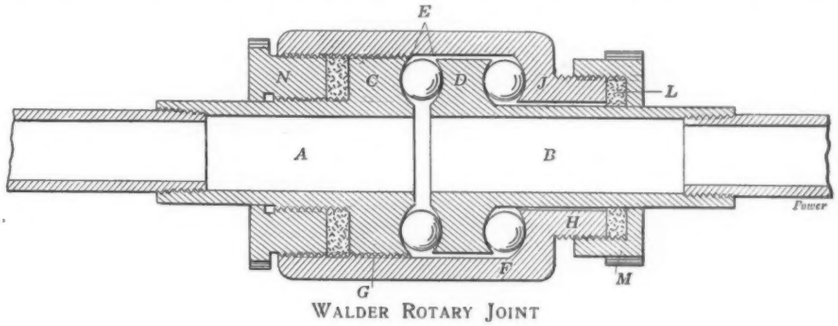
Walder Rotary Joint

This joint is a connection for steam or other pipes containing fluid under pressure and is designed to form a liquid-tight connection between ends of two pipes and at the same time to permit such pipes to have free turning movements.

In the accompanying illustration is shown a longitudinal section of two pipes connected by this type of joint. The spaced ends of the pipes are threaded to the outer ends of the tubular members *A* and *B*, respectively. These members each have at their inner end annular shoulders or enlargements, as shown at *C* and *D*, the end faces of which are divided with annular concave seats or runways *E* for the interposed balls. A sleeve *F* is threaded to the enlargement *C*, as shown at *G*, and its opposite end is reduced as shown at *H*.

Between the shoulder *J*, which is formed by reducing the end of the sleeve *F*, and the shoulder *D*, are placed a set of balls, the shoulders having their faces concaved to provide suitable runways for the balls. Leakage is prevented between the members *B* and the reduced end *H* by a suitable packing ring *L*, which is pressed closely to the member *B* and to the reduced end of the sleeve by a gland *M*.

N designates a nut which is screwed into the large end of the sleeve and onto the member *A* and serves to lock the sleeve *F* in an adjusted position relative to the member *A*. To overcome any leak-



WALDER ROTARY JOINT

age, which might otherwise occur between the sleeves and the shoulder on *A*, a suitable packing is used.

It is evident that with this construction the member *B* and its attached pipe are permitted to have free turning movement relative to the member *A*, as shown, the sleeve *F* and the packing parts, and that the opposite thrusts of the shoulders against the sets of balls may be adjusted to a nicety to prevent longitudinal play between such parts.

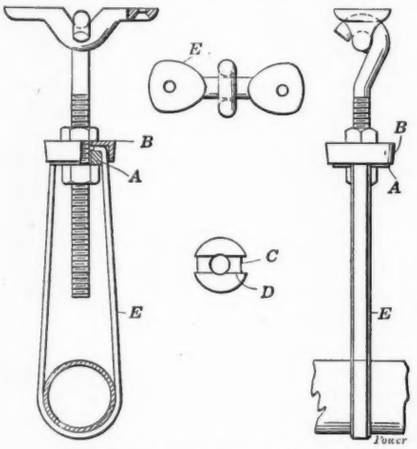
This joint is the invention of August Walder, Archibald, O.

Improved Pipe Hanger

This hanger, illustrated herewith, is constructed so as to be put up either before or after the piping is hung. It is adjustable, so as to maintain the alinement of the pipe and also to allow for expansion and contraction.

The drawings show an elevation of the hanger, partly broken away to illustrate the construction, and also a side view. The hanger consists of a threaded shank that passes through a sliding block *A* and sliding cap *B*, both of which are provided with a central opening for the shank piece to pass through. The block is provided with side recesses, as shown in *C*, being opposite to each other, and a top recess *D* is also provided.

The pipe is supported by a spring loop, the upper turned-in ends of which lie in the side recesses in the block *A*.



TWO VIEWS OF PIPE HANGER

When the two nuts are screwed down tight, the ends of the spring loop is held in place between the block and cap. The whole swings on the head of a shank piece, which is suspended by the holder shown at *E*. This allows for expansion; the adjustible nuts permit of raising or lowering the pipe. The device is the invention of Elmer A. Roberts, Norwalk, Conn.

If the wood handle has been broken from a monkey wrench, a serviceable substitute can be made by slipping a piece of hose over the wrench, then filling the hose with babbitt.

Minneapolis in Darkness

On January 6, the power plant of the General Electric Company, furnishing current to the city, was visited by fire. Crossed wires in the engine room started the trouble. Electrical machinery of 6000 kilowatts capacity was reported to be totally destroyed. The city was dark on Friday night, but on Saturday normal conditions were restored with the load on the St. Croix station. Full particulars will be given in an early issue.

OBITUARY

At the age of 54, Patrick Mullen died on Tuesday, January 3, at the New York home for the aged, where he had held the position of chief engineer for the past twenty-eight years. Mr. Mullen was an earnest and active member of the Eccentric Association of Engineers No. 1, of New York City, and was always an energetic worker for the betterment of the condition of the engineer. His ambition was to see the engineers of Greater New York united in one body. Mr. Mullen had a host of friends and his loss will be keenly felt.

The Germantown council, American Order of Steam Engineers, announce the demise of Past Chief William M. Leitch. Mr. Leitch took an active interest in the affairs of the American Order, both subordinate and supreme. The American Order of Steam Engineers Exchange, of which he was chairman, was a direct result of his activities in securing employment for engineers. Practically, during the time he was a member of Germantown council, he took special interest in this important work, and during the time prior to organization of the exchange, he had through his own efforts secured more than 150 positions. His reputation in this respect became circulated throughout the engineering fraternity of Philadelphia.

At the Baltimore convention, 1908, Mr. Leitch was nominated for supreme chief engineer, and, although unsuccessful at that time, he did not allow this defeat to affect his attitude or efforts toward the welfare of the members of the American Order. He was conscientious in everything that he did, and was considered one of the most capable engineers in Philadelphia. For a number of years he had been employed by the William H. Hoskins Company, Philadelphia, as chief engineer, and was still connected with that company at the time of his death.

PERSONAL

C. O. E. Sanders has associated himself with the Thermoid Rubber Company, of Trenton, N. J., which will put upon the market a line of mechanical rubber goods, including packings, in which field Mr. Sanders has already made a reputation.

On January 4, W. H. Whiteside resigned the presidency of the Allis-Chalmers Company, which position he has held for about six years. Mr. Whiteside's first industrial connection was with the Hercules Powder Company in 1881. Four years later he went over to the Cleveland Electric Manufacturing Company, where he remained 12 years. He then became manager of engine sales for the Gates Iron Works, of Chicago. Two years later he was placed in charge of the Wilmington office of the Westinghouse Electric and Manufacturing Company. D. W. Call, formerly assistant to the president of the American Steel Foundry Company, has been chosen as successor to Mr. Whiteside.

BOOKS RECEIVED

PHYSICAL SIGNIFICANCE OF ENTROPY. By J. F. Klein. D. Van Nostrand Company, New York. Cloth; 98 pages, 6x9 inches. Price, $1.50.

QUALITATIVE CHEMICAL ANALYSIS. By J. I. D. Hinds. The Chemical Publishing Company, Easton, Penn. Cloth; 264 pages, 5½x9 inches; indexed. Price, $2.

International Municipal Congress

Hon. John MacVicar has been selected for the position of commissioner-general of the International Municipal Congress and Exposition, to be held in Chicago, September 18 to 30, 1911. John MacVicar is a well known authority in this country on all that pertains to municipal government and the administrative affairs of cities. He has been in active service in municipal work for more than twenty years. He was named to the office of president of the League of American Municipalities upon its organization, fifteen years ago, and has ever since been actively connected with that organization, for the past ten years as secretary. Mr. MacVicar is at present a member of the commission, and superintendent of streets and public improvements, at Des Moines, Ia., which city has recently attracted some attention because of its advanced form of government.

This congress and exposition will cover in a practical as well as theoretical manner matters of interest to all branches of municipal service. Upon each day of the congress, papers will be read and discussed by prominent municipal officials, and prominent municipalities of this country and foreign countries will have attractive exhibits of municipal undertakings in which they excel.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

HYDRAULIC MOTOR. Wallace C. Kelly, Hastings, Mich. 979,511.

INTERNAL COMBUSTION POWER GENERATOR. Alfred Pelletier, Chicago, Ill. 979,554.

TURBINE. Thomas James Westerman, Olalla, Wash. 979,619.

ROTARY ENGINE. George E. Ball, Cranston, R. I. 979,638.

TURBINE. Alonzo W. Bennett, Hamden, Conn. 979,735.

INTERNAL COMBUSTION ENGINE. Adolph Peteler, New York, N. Y. 979,794.

TWO-CYCLE INTERNAL COMBUSTION MOTOR. Frederick Lamplough, London, Eng. 979,971.

ROTARY ENGINE. Horace Doke, Greeley, Colo. 980,075.

TWO-CYCLE INTERNAL COMBUSTION ENGINE. Charles E. Maud, Monterey, Cal. 980,110.

EXPLOSIVE ENGINE. Frank W. Springer, Minneapolis, Minn. 980,134.

WINDMILL. William P. Brett, Decatur, Ill. 980,172.

BOILERS, FURNACES AND GAS PRODUCERS

BRICK FOR FLAME WALLS OF WATER-TUBE BOILERS. Thomas G. Turner, New York, N. Y., assignor to Turner Baffle-Wall and Boiler Company, a Corporation of New York. 979,604.

FURNACE GRATE. George Minion, Chicago, Ill., assignor of one-fifth to James Belle, one-tenth to Charles H. Scheuer, one-fifth to Ernest H. Miller, and one-fifth to John Robertson, Chicago, Ill. 979,783.

FURNACE TILE. George Wm. Wood, Camden, N. J., assignor of one-half to Michael Shapiro, Camden, N. J. 979,627.

FURNACE. John R. Fortune, Detroit, Mich. 979,661.

AUTOMATIC STOKER. William T. Hanna, Cincinnati, Ohio, assignor, by mesne assignments, to the Mechanical Construction Company, Cincinnati, Ohio, a Corporation of Ohio. 979,850.

GAS-PRODUCING FURNACE. Robert Hilprecht, Lansing, Mich. 979,951.

POWER PLANT AUXILIARIES AND APPLIANCES

HOSE COUPLING. Ed. J. Hannold, Mexico, Mo., assignor, by mesne assignments, to C. M. Clay. 979,481.

LUBRICATOR SYSTEM. William S. Harley, Milwaukee, Wis. 979,484.

FLEXIBLE PIPE JOINT. Johann Koenig, Riga, Russia. 979,513.

VALVE. Frank A. Merrill, Malden, and John S. C. Nicholls, Boston, Mass., assignors of one-third to William G. Merrill, Malden, Mass. 979,532.

FEED-WATER HEATER AND SEPARATOR. Axel Blytt Wallem, Moores, Penn., assignor to Joseph S. Lovering, Wharton, William S. Hallowell and John C. Jones, doing business under the firm name of Harrison Safety Boiler Works, Philadelphia, Penn. 979,612.

VALVE. Axel B. Wallem, Moores, Penn., assignor to Harrison Safety Boiler Works, Philadelphia, Penn., a Corporation of Pennsylvania. 979,811.

GREASE CUP. James F. Craven, Pittsburg, Penn., assignor to Craven Engineering Company, Pittsburg, Penn., a Corporation of Pennsylvania. 979,826.

VALVE. Ferdinand Messmer, Jr., St. Louis, Mo. 979,874.

GOVERNOR FOR INTERNAL COMBUSTION ENGINES. David Roberts, Alfred Rowe Bellamy, and Charles James, Grantham, England. 979,888.

VALVE-OPERATING MECHANISM FOR USE IN INTERNAL COMBUSTION ENGINES. Gustavus Green, Bexhill, England. 979,943.

LINER FOR STEAM PUMPS. Horace G. Johnston, Corsicana, Tex. 979,960.

VALVE DISK CUTTING MACHINE. Frank L. Smith, Chicago, Ill., and Thomas B. Williams, Orange, Mass., assignors to the Leavitt Machine Company, Orange, Mass., a Corporation of Massachusetts. 980,019.

FEED-WATER REGULATOR. Thomas R. Whittaker, Lawrence, Mass. 980,037.

LOCKING DEVICE FOR LUBRICATING CUPS. Kos M. Anderson, Temple, Tex. 980,043.

VALVE ARRANGEMENT FOR CONTROLLING FLUID TRANSMISSION GEARS. Hugo Lentz, Mannheim, Germany. 980,106.

PIPE COUPLING. Henry Mueller, Decatur, Ill.; Ora B. Mueller and Adolph Mueller, executors of said Henry Mueller, deceased, assignors to H. Mueller Manufacturing Company, Decatur, Ill., a Corporation of Illinois. 980,116.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC STREET LIGHTING. Carl Henry Froelich, St. Louis, Mo. 979,459.

ELECTRIC MOTOR. Charles Backer, New York, N. Y., assignor of forty-nine hundredths to Rudolph Rosenfeld, New York, N. Y. 979,637.

ELECTRICAL HEATER. Frank Kuhn, Detroit, Mich., assignor to American Electrical Heater Company, Detroit, Mich., a Corporation of Michigan. 979,515.

ELECTRIC CABLE CONNECTION. Lewis H. Church, Stamford, Conn., assignor to the Standard Electric Fittings Company, Stamford, Conn., a Corporation of Connecticut. 979,651.

ELECTRIC SWITCH. Roy D. Snyder, Delta, Penn. 979,894.

ELECTRIC SOLDERING IRON. Alvin H. Waage and Clarence P. Waage, Chicago, Ill. 979,904.

ELECTROLYTIC CELL. Fritz Weinberg, New York, N. Y., assignor of two-thirds to Emile Berliner, Washington, D. C. 979,906.

ELECTRIC IGNITION APPARATUS FOR INTERNAL COMBUSTION ENGINES. Frank Herbert Alston, Birmingham, England, assignor of one-half to Boultbee Brooks, Birmingham, England. 979,912.

METHOD OF ELECTRIC WELDING. Laurence S. Lachman, New York, N. Y., assignor to Universal Electric Welding Company, a Corporation of New York. 979,970.

ROTOR FOR HIGH-SPEED ELECTRICAL MACHINES. Henry H. Wait, Chicago, Ill. 980,032.

MAGNETO ELECTRIC GENERATOR. Thomas S. Hemenway, Buffalo, N. Y., assignor to Ericsson Manufacturing Company, Tonawanda, N. Y., a Corporation of New York. 980,153.

COMBINED ELECTRIC CONNECTION PLUG AND SOCKET AND SWITCH. William W. Buckton, London, England. 978,841.

CIRCUIT CLOSER. Henry B. Collier, Prairie Grove, Ark. 978,849.

CIRCUIT BREAKER. Ford W. Harris, Wilkinsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 978,882.

ELECTRIC CIRCUIT-CHANGING MECHANISM. Frank B. Hall, Wheeling, W. Va. 978,879.

AUTOMATIC ELECTRIC PUMP CONTROL. Thomas F. Mulligan, Fort Wayne, Ind., assignor to S. F. Bowser & Co., Inc., Fort Wayne, Ind., a Corporation of Indiana. 978,923.

LIGHTNING ARRESTER. Percy H. Thomas, Montclair, N. J., assignor to Cooper Hewitt Electric Company, New York, N. Y., a Corporation of New York. 978,959.

POWER PLANT TOOLS

JACK SCREW. Edward M. Burney, Chicago, Ill. 979,424.

BELT STRETCHER. Frederick Thomas, London, England. 979,599.

PIPE REAMER. Peter Neerup, Louisiana, Mo., assignor to Reliable Tool and Specialty Company, Louisiana, Mo., a Corporation of Missouri. 979,786.

WRENCH. Arthur E. Smiley, Springfield, Mass. 979,805.

RATCHET MECHANISM FOR SCREW DRIVERS AND THE LIKE. Willey B. Lane, New York, N. Y., assignor of one-half to J. C. McCarty & Co., a Corporation of New York. 979,862.

SOLDERING TOOL. Reinold Staehle, Mt. Vernon, N. Y. 979,896.

ADJUSTABLE POST FOR RATCHET DRILLS. Charles B. Hastings, New York, N. Y. 980,100.

WRENCH. John F. Anderson, San Francisco, Cal. 978,827.

WRENCH. Joseph Charles Noll, Fort Wayne, Ind. 979,330.

WRENCH. Henry D. Smith, Brownsboro, Tex. 979,348.

WRENCH. Jack R. Davis, Duson, La. 978,856.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston, Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.

BUSINESS ITEMS

The Robb Engineering Company, Ltd., has purchased the Robb-Mumford Boiler Works, at South Framingham, Mass. The management and manufacturing organization will be continued as at present.

Franklin Williams, manufacturer of engineering specialties, 39 Cortlandt street, New York, is issuing a rather unusual calendar, which is so compact as to include the whole year within very small compass. It might be called a thumb-nail calendar, and should prove useful to busy people.

The Nelson Valve Company, Philadelphia, Penn., is sending to engineers on application a set of danger signs to hang on valve wheels, etc., to show that the wheel is to be left alone until the sign has been removed by the proper authority. Send and get a set, they are handy and useful.

The Murphy Iron Works, manufacturer of the Murphy automatic furnace, has arranged for an office in Atlanta, the same to be in charge of Roland B. Hall, Jr., who will handle its business in connection with that of the Harrisburg Foundry and Machine Works, whom he has represented in the southern territory for some time. Mr. Hall's offices are located in the Empire building, and he will be very glad to furnish any information regarding the Murphy automatic smokeless furnace that may be desired.

Bulletin No. 130 has been issued by the Bristol Company, Waterbury, Conn. It is a 56-page illustrated catalog of the Wm. M. Bristol electric pyrometers and includes description and lists of both indicating and recording forms of these pyrometers with explanation of the special patented features, as for instance basic patents on means of compensating readings of thermo-electric pyrometers for changes in cold-end temperature. On pages 48 to 55 of this catalog partial list of more than 700 users of the Bristol pyrometers is given.

The Royersford Foundry and Machine Company, of Royersford, Penn., manufacturer of the Sells roller bearings, found it so difficult to obtain a satisfactory lubricant for its roller bearings that it has brought out a lubricant of its own, which is especially adapted to meet the requirement of bearing lubrication. "Rollerine" is the name it has adopted for this special bearing lubricant. Anyone writing to the Royersford Foundry and Machine Company, at its Philadelphia office, 52 North Fifth street, can obtain full information on both Rollerine and Sells roller bearings.

NEW EQUIPMENT

Gleichen, Alberta, will install a new waterworks system.

New Carlisle, Ohio, will construct waterworks system.

The citizens of Rush, Tex., voted to issue bonds for waterworks.

Chilliwack, B. C., will spend $40,000 extending waterworks system.

C. F. Melinde, Hudson, N. H., is building an addition to his engine room.

Whittemore, Iowa, has voted to issue $7000 bonds for municipal waterworks.

Swift & Co., of Chicago, will erect a cold-storage plant at Muskogee, Okla.

Falls City, Ore., will issue $30,000 bonds for the construction of waterworks.

Leavenworth, Wash., will construct a water-supply system to cost $40,000.

Hopkins, Mo., is considering the construction of a municipal waterworks system.

The Lynn (Mass.) Storage Company will erect a warehouse and cold-storage plant.

The city of Alturas, Cal., has voted $33,000 bonds for improvements to its waterworks.

The Farmers Union, Chico, Cal., will erect a warehouse and install refrigerating plant.

The Calexico (Cal.) Creamery Association will build a creamery and cold-storage plant.

The Canadian General Electric Company will erect a $100,000 power house at Auburn, Ont.

S. S. & T. B. Davis, Rock Island, Ill., will erect and equip a large power house on Rock river.

The town of Woodbury, N. Y., is considering the construction of a municipal water plant.

The city of Fairburn, Ga., will vote on issuance of $10,000 bonds for electric-light plant.

The citizens of Lyndhurst, N. J., voted to issue $25,000 bonds for extending its waterworks.

The Standard Furniture Company, Portland, Me., is in the market for an air compressor.

Smithfield, Va., will vote on issuance of $55,000 bonds for electric-light and sewerage systems.

Martinsville, Va., voted to issue $35,000 for improving its electric-light plant and waterworks.

The Libby (Mont.) Water Works, Electric Light and Power Company will install a lighting system.

Strathcona, Alberta, will considerably increase electrical equipment in the municipal power plant.

The Truckee River General Electric Company, Reno, Nev., will build a power plant on the Truckee river.

Improvements will be made to the power and light plant at the Boys Industrial School, Lancaster, Ohio.

It is reported the Jacksonville (Fla.) Electric Company will erect a power house on Riverside avenue.

The citizens of Sierre Madre, Cal., voted to issue $40,000 bonds for waterworks. P. C. Carter, city clerk.

The Duquesne Light Company, Pittsburg, Penn., will erect a new power house on Shakespeare street.

The citizens of Boone, Iowa, voted to issue $180,000 bonds for extending waterworks. Otto Hile, city clerk.

The Siloam Springs (Ark.) Ice and Cold Storage Company's plant was destroyed by fire. Loss, $150,000.

E. B. Hillman, of Peoria, Ill., has been granted franchise to erect an electric-light plant at Hamburg, Iowa.

The Olympia Railroad and Power Company, Elma, Wash., is planning for extensive power-plant enlargement.

The Pacific Mill, Lawrence, Mass., will install a steam turbine and electric generator of 3250 kilowatts capacity.

The Wilkes Barre (Penn.) Railway will erect a three-story addition to its power house on South Main street.

A five-story packing plant will be erected for the Hammond-Standish Company, 20 Cadillac square, Detroit, Mich.

The Morrison Electrical Company, Boston, Mass., is in the market for a 15-kilowatt direct-connected generating set.

The Eastern Oregon Light and Power Company, Canyon City, Ore., will build a hydroelectric plant at Lagoon lake.

The Steelton (Penn.) Light, Heat and Power Company is reported to be planning the erection of an electric plant.

The city of Polytechnic, Tex., is considering the construction of a municipal waterworks plant to cost about $32,000.

The Oklahoma City (Okla.) Railway Company will spend $125,000 in making additions to its power station at Belle Isle.

The People's Power Company, Rock Island, Ill., is planning extension and improvements at its gas and electric-light plant.

The Atlantic Ice and Coal Corporation, Albany, Ga., has awarded contract for the erection of a new engine and power house.

The Norfolk & Western Railway will enlarge its power house at Bluefield, W. Va. Two additional boilers will be installed.

The city of Georgetown, Tex., will spend about $30,000 improving its waterworks and electric-light plant. R. E. Ward, mayor.

Vancouver, B. C., will buy one 1500-kilowatt steam turbine generating unit and one 500-kilowatt, direct-current generating unit.

J. A. Haberer, town clerk, Rippey, Iowa, will receive bids until February 6, for furnishing material and constructing waterworks.

The Northwestern Development Company, Spokane, Wash., will build a 30,000-horsepower hydroelectric plant to cost about $1,800,000.

The town of Roberta, Ga., will receive bids through W. J. Marshall, Lizell, Ga., for the construction of an electric power and pumping plant.

The board of water and light commissions, of Bayfield, Wis., has completed plans for a new boiler house for the municipal water and light plant.

The Eastern Michigan Edison Company, of Pontiac, Mich., is said to be planning the erection of a 5000-horsepower steam-electric plant, near Amy.

The Woodlawn (Ala.) Ice Company has been incorporated with $40,000 capital to manufacture ice. W. J. Worthington, president and treasurer.

The Union Power Company, Hagerstown, Md., has had plans completed for a new power house. O. G. Keilholtz, Continental building, Baltimore, is engineer.

The Twin City Light and Traction Company will erect a new generating plant at Chehalis, Wash. Headquarters are in the Trenton building, Portland, Ore.

The Leader Publishing Company, owners of the *Cleveland Leader*, is planning to erect a 14-story building with an estimated cost of $1,000,000 to $1,500,000. An electric power plant for operating the presses will be installed.

Bids will be received until January 19 by R. G. Arthur, secretary, board of water commissioners, Douglas, Ariz., for furnishing material and making improvements to waterworks, including pumping plant, pump house, etc. About $85,000 will be expended.

E. M. Statler, of Buffalo, N. Y., will erect a hotel building in Cleveland, at the corner of Euclid avenue and East Twelfth street, and has commissioned George B. Post & Sons, architects, Cleveland, to prepare the plans for the structure. The estimated cost of this work is $2,500,000.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent steam specialty salesman: one that can sell high grade goods. Address "M. M. Co.," POWER.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

How often we hear that expression, "The power behind the throne."

Napoleon got all the credit for the tremendous schemes he successfully put through, but some astute historians believe that Talleyrand was the instigator of most of them.

He was the "power behind"—the *real* influence.

This illustration is often brought to our notice by advertisers.

"Are you getting responses to your advertising?" we ask.

"Oh, yes," is the reply, "but most of them come from operating engineers and we rather doubt their value.

"Engineers often have the say in regard to ordinary small supplies such as packing, gaskets, oils, grease, etc.—or even valves and injectors—but when it comes to the big things such as engines, boilers, etc., you need not bother with the engineer—get right next to the man who signs the order."

Let's see about that.

A prominent engine builder the other day was talking about some recent orders he had won and lost through the engineer's influence.

Two cases will illustrate.

The managing owner of a textile mill was considering the installation of a new compound engine made necessary by enlargements of the mill.

The operating engineer was consulted and recommended a certain make of Corliss engine. The representative of the engine builder who told the story was very anxious that his company should secure the order—he made a proposition that he would pay the expenses of the mill owner and his engineer if they would come to his shops and inspect his make of engine. The offer was accepted. The mill owner sat in the office while the engineer went through the shop. The engineer made no comments while on the tour of inspection.

After returning to the office he was asked by the mill owner what he thought about it.

"Well," he said, "I find I was mistaken in my ideas regarding this engine; it is quite different than I thought it was."

The mill owner asked, "Would you recommend our putting it in our plant?" "Yes," said the engineer.

The order was fixed up and signed that afternoon.

The other case:

A representative of the engine builder before mentioned thought he had an order all cinched for a large engine to go in a plant near Boston. The owners had about decided to give him the order—but their operating engineer was insistent that another make be installed. After waiting for nearly a week before deciding, the order was placed with the builder of the engine the engineer wanted.

In neither case did the engineer give or sign the order—and to the layman his influence was unknown and unseen.

But it was there.

It should be and is, in most cases, a part of the engineer's duties to recommend the installation of power-plant machinery.

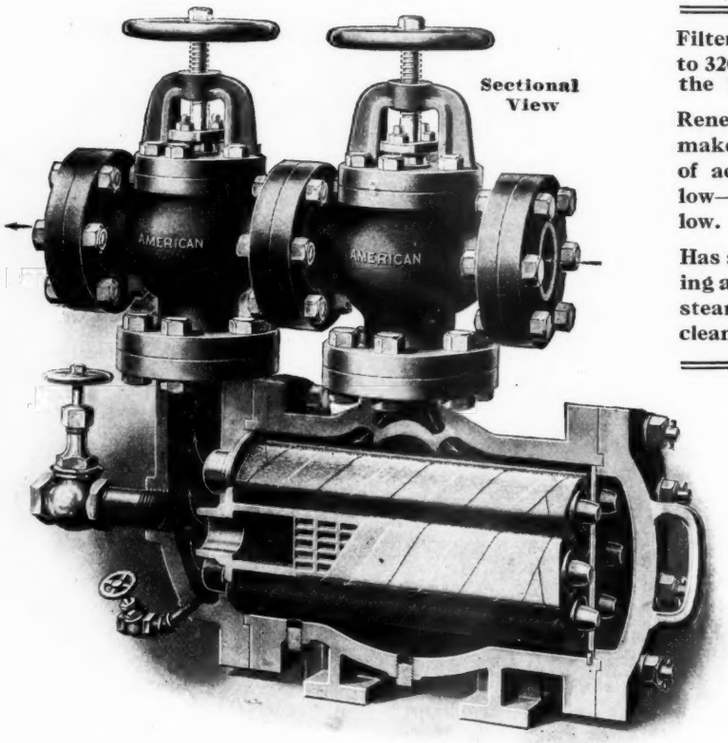
It is a job for a specialist, and that specialist is the engineer in charge, either alone or in cooperation with a consulting engineer.

The man in the "front office" in nine cases out of ten is a specialist in some other line—he's interested in what he is making and marketing.

There is only one man he can rely upon in power matters and that is a power man.

It behooves the progressive power man to know what's what in power-plant machinery and in no other place can he find as much information as in the pages—reading and advertising—of his technical paper.

Use An American H_2O Grease Extracting Feed Water Filter



Sectional View

Filtering surface equal to 320 times the area of the feed water pipes.

Renewals very easy to make. Every part easy of access. First cost low—maintenance cost low.

Has a device for applying a reverse current of steam for temporary cleaning.

To Keep Oil And Grease Out Of The Feed Water

Bagging is one of the chief boiler evils—at once the most troublesome and dangerous.

It weakens the boiler, reduces its capacity, causes excessive coal bills, and very often causes explosion.

Yet there is no mystery to bagging; it can easily be prevented.

Bagging is caused by oil or grease getting into the feed water, sticking to the tubes or sheets, and forming a non-conductive crust—

Which causes overheating of the metal, softening and bagging.

So keep out the oil and grease and you'll have no bagging to cause trouble, you'll save coal, increase the capacity *and the life* of the boiler.

Keep oil or grease out of the feed water by means of the simply constructed, compact, American H_2O Grease Extracting Feed Water Filter.

This device is not only absolutely reliable in operation, but it takes up little room and is easy to clean and cheap to maintain.

Investigate it—investigation puts you under no obligations .

Write for our Filter Booklet.

American Steam Gauge and Valve Mfg. Company

New York Chicago Boston, Mass. Pittsburg Atlanta

Letters that prove absolutely that the American-Thompson Indicator helps its owners secure higher positions

Note dates of the letters, please.

From Mr. Cole, *Engineer*

Harlingen, Texas, Nov. 25, 1910

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Gentlemen:—

The indicator I ordered from you has arrived all O. K. I find it all right, too, as it has helped me to locate a trouble that is so often attributed to the engine itself. On applying the instrument I found I was pulling almost one-fifth more load from one end of the engine than the other, which naturally caused a pound. The manager didn't believe in the indicator until he saw this trouble located. Then he said no engineer who didn't use an indicator could ever run for him. Very truly yours,

L. G. Cole, Engineer,
Harlingen Ice & Gin Co.

We Ask A Favor

Boston, December 8, 1910

Mr. L. G. Cole, Engineer, Harlingen, Texas.

Dear Sir:—

Referring to your letter of November 25th, we wish to ask you if it would be possible for you to get a letter from your manager to the effect that the results you obtained with your indicator made him resolve to hire in the future only engineers who worked with the aid of an indicator. Yours very truly,

American Steam Gauge & Valve Co.

From Mr. Cole, *Manager*

HARLINGEN ICE & GIN COMPANY

Harlingen, Texas, Dec. 20, '10

American Steam Gauge & Valve Mfg. Co.,
Boston, Mass

Gentlemen—

Yours of Dec. 8 just before me. The manager who was here at the time I ordered and received the indicator from you is gone. However, I attribute my success as much to the use of the indicator as anything else.

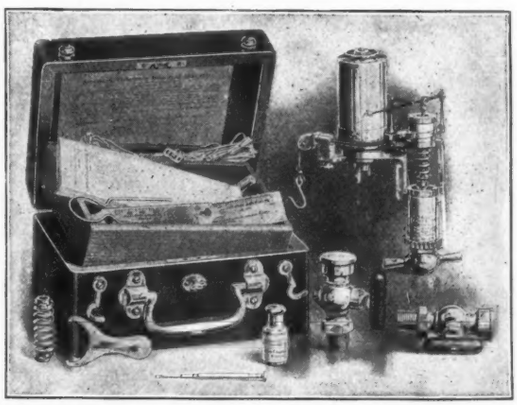
I have been promoted from engineer to manager, and one would naturally suppose that if the results as engineer were not satisfactory, one would not have very much chance of getting the management. If a letter from me would be of any service to you, I will give it. The indicator isn't a new thing to me, I have used several different makes and in my opinion there isn't another the equal of the American-Thompson. Very truly yours, L. G. Cole.

These letters prove absolutely every claim we have made for the American-Thompson.

1. ***That the indicator will help you secure promotion.***
2. ***That plant managers recognize the importance of indicators to engineers.***
3. ***That the American-Thompson is the only real indicator.***

$5.00 brings it to you—$5.00 monthly pays the balance. Mail the coupon for full details.

This did it



Mail It Today

The Outfit

The Indicator, inclosed or exposed spring type as preferred, two single cocks or one 3-way cock (as preferred), one scale, all necessary wrenches, screw-driver, bottle of porpoise oil, etc., all inclosed in a neat mahogany box, together with 200-page book—Indicator Instructions.

The Terms

Suitable references and an initial payment of $5.00 secure the Indicator Outfit at once. $5.00 a month pays the balance. The total cost is $55 (Detent Motion extra). You may have the outfit for examination without risk whatever.

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Send me full details of your Indicator Offer No. 93.

Name . . . . . .

Address . . . . . .

City and State . . . . . .

WANTED—Experienced steam fitter foreman for manufacturing plant; state age, reference and salary expected. Address "CX," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn street, Chicago.

WANTED—Chief engineer for power plant, about one hundred miles from New York City; power plant consists of Curtis turbines and generators; also have charge of motors throughout industrial works in which this power plant is located; in answering give age, experience and salary expected. Box 346, POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

MECHANICAL ENGINEER, technical man, experienced in the development and design of modern manufacturing and power plants. Box 342, POWER.

Fireman, age thirty, strictly temperate, three years' practical experience, graduate of International Correspondence Schools, stationary fireman's course, wants position. Box 351, POWER.

STATIONARY ENGINEER, 10 years' experience alternating and direct current; first-class State license; age 35; strictly sober; own tools, including indicator; go anywhere; good references. Box 352, POWER.

WANTED—Position as engineer by young married man, experienced in operating alternating- and direct-current generators, Corliss and automatic engines, return tubular and water tube boilers; references. Address Box 354, POWER.

POSITION WANTED as engineer, or in charge of repairs and maintenance of power and mechanical apparatus in manufacturing plant; had experience in electric power stations, machine shops and manufacturing plants, and especially steam engine repairs. Box 353, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

WANTED—Agents, engineers preferred, to sell boiler cleaning chemicals; liberal commissions paid. Continental Chemical Co., Forest Bldg., Philadelphia, Penn.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

THE ANNUAL MEETING of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the offices of the company, in the Hallenbeck building, 497-505 Pearl street, Borough of Manhattan, New York City, N. Y., on Tuesday, January 31, 1911, at 12 o'clock noon.

Dated, New York City, December 9, 1910.
Robert McKean, Secretary.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—Small screw cutting lathe, chuck and tools; fine condition; bargain. South Bend Machine Co., South Bend, Ind., 424 Madison St.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ENGINE FOR SALE CHEAP, Professor Sweet straight line, 11-inch bore, 16-inch stroke, in first-class condition. Chief engineer, Parker, Stearns & Co., 300 Sheffield Ave., Brooklyn, N. Y.

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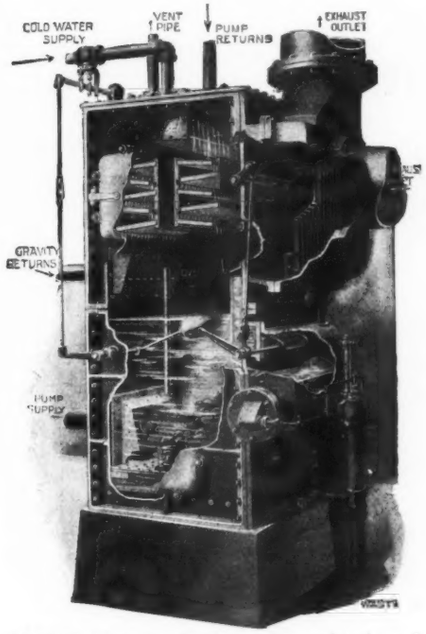
Why The Cochrane Heater Is The Best On The Market

For over 20 years we have been building the Cochrane Open Feed Water Heaters. In that time we have turned out and had placed in service many more than **6,000,000 H. P. of these "Cochranes."** It has been our constant aim to make these heaters as good and as practical in every respect as it is possible to make them,so that we would lead the market, which means giving to the user **the best, the most convenient, the most serviceable, and the most durable heaters** that ingenuity, good materials, and careful workmanship could produce.

People who own, design and operate steam power plants want the best; we give it to them, and as a result we have had the opportunity of building more heaters than any other concern in the world. Every improvement that experience could suggest has been carefully tried out and adopted when good. All the best ideas and improvements are yours when you buy "Cochranes." It is easy to skimp in the manufacture of heaters, just as it is in the building of houses, or the making of pies. A good many things can be left out, and still it will be a heater, or a house, or a pie, but it may not be the kind of heater, house or pie that you want, and are willing to pay for, when you know what you are getting.



Interior View of Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver.

Cochrane Heaters are designed for discriminating buyers, who take pains to see that they get what will be of most **value** to them. They do not want anything left out that is worth putting in. For instance, it is cheaper to leave off the separator, or to put it inside the heater shell, than it is to provide a good oil separator attached to the outside of the shell. Again, it is cheaper to leave off the overflow chamber or trap in heaters and receivers, but it is not safe to do so, and therefore we provide a steam trap, and a good one, too.

Naturally, it does not cost as much to build a small heater as a large one, but a certain size is needed to secure the best results in the settlement, filtration and purification of the water, and for driving off air and gases from the water, so that it will not corrode the boiler. We could get plenty of floats cheaper than the one we use, but our ventilated copper float is much the more satisfactory, and in case it does leak, it will indicate the fact at once.

A cheaper heater could be constructed by using steel shells in place of cast iron shells, but they do not last as long, and they give trouble by leaking, so you don't want them.

In other words, we have gone into the heater business to build heaters to fulfill requirements. We have taken the trouble necessary to find out just what is wanted. We have devised different attachments, types, etc., for plants operating under back pressure, for plants where they have bad feed water, for plants where they wish to use the surplus exhaust steam in a heating or drying system, etc.

One of our latest improvements enables the purchaser to save from $50 to $500 on the first cost of the installation, and to secure a better and more convenient arrangement into the bargain. We refer to our Cochrane Steam-Stack and Cut-Out Valve type of Heater and Receiver for use in connection with exhaust steam heating or drying systems. (See illustration.(

If you will send us particulars about your plant, how much water you wish to heat, how much exhaust steam you have available, and the uses that you wish to make of hot water or purified exhaust steam, as for running exhaust turbines, absorption ice machines, cooking, heating, drying, etc.; we shall be pleased to give you the benefit of our suggestions, not only as to the apparatus to be used, but as to the best method of arranging it to secure the most satisfactory results. We have had long experience in these matters, and many times our advice has been worth more to the purchaser than our apparatus cost him. Send for our book on the "*Profitable Use of Exhaust Steam.*"

Engineering Department

HARRISION SAFETY BOILER WORKS

17th AND CLEARFIELD STS. PHILADELPHIA, PA.

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Power Specialty Co. 86
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Dart Mfg. Co., E. M. 95
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